

The Journal of Laryngology and Otology

(Founded in 1887 by MORELL MACKENZIE and NORRIS WOLFENDEN)

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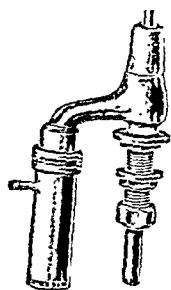
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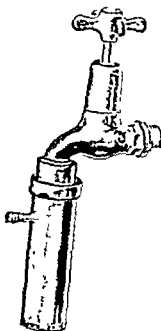
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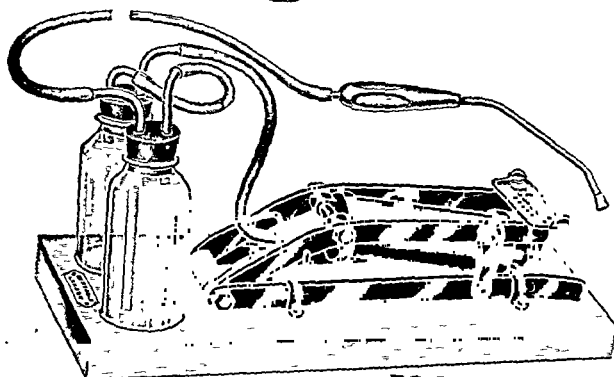


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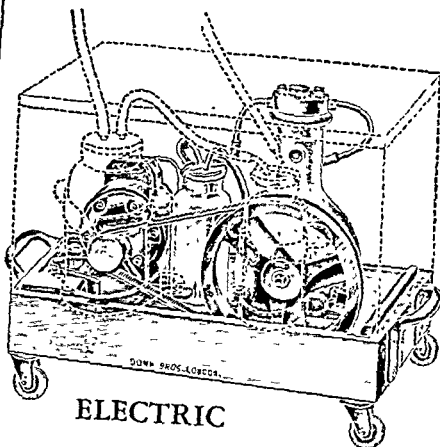
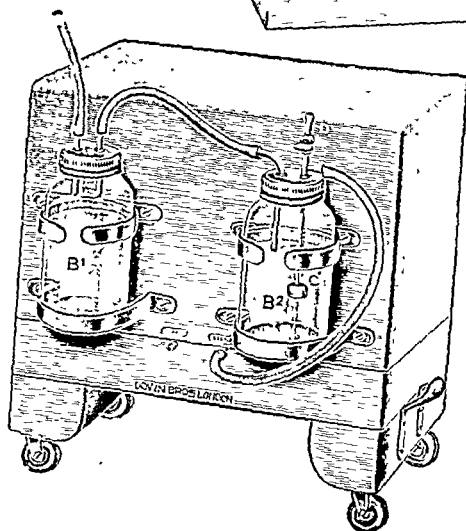


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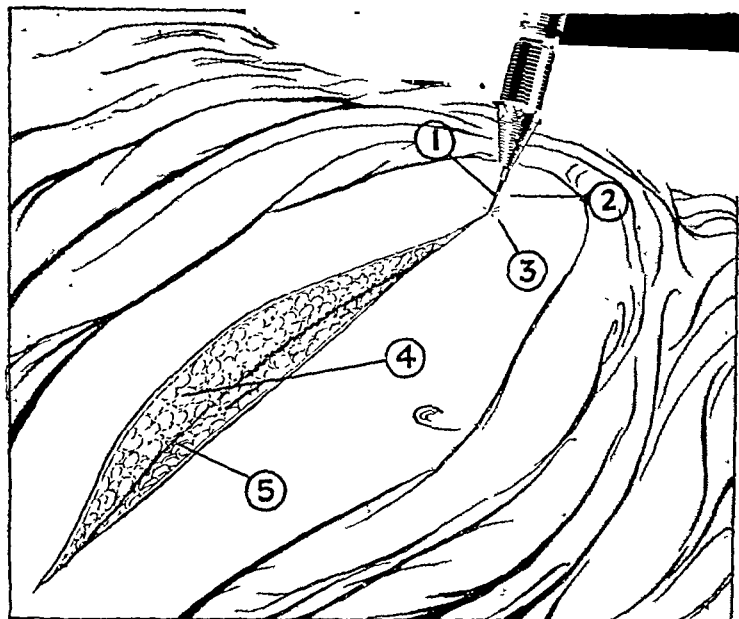
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April 1948

A CONTRIBUTION TO THE QUESTION OF OTITIS MEDIA IN INFANTS

By ANDREJ MARES (Plzen, Czechoslovakia)

RESEARCH into the problem of otitis media in infants started already at the end of the last century, and, after the early remarkable discoveries of Preysing and Witmaack, attained great success during the past ten years. However, in spite of the fact that this problem has been largely elucidated, we still find in world literature contradictory reports, especially so far as the valuation, and, in connection with that, the treatment of these cases of otitis are concerned.

It is generally acknowledged that the infant during the first year of life is more inclined to be affected by otitis media than in the following years. The reasons for that are :

- (1) The greater susceptibility of the infant to infection.
- (2) The anatomical conditions of the middle ear, i.e.
 - (a) the short and wide eustachian tube which is placed in a rather horizontal position and is not protected by the tubal wall,
 - (b) the peculiarities of the middle-ear mucosa, i.e. remnants of mucosa of embryonal structure.

Witmaack described the so-called " otitis media neonatorum ", which is the reaction upon penetration of foreign bodies into the middle ear, and causes a special predisposition to further inflammations, which can be caused even by less virulent organisms. Preysing found in a great number of cases sterile inflammatory changes of the middle ear. Cases

Andrej Mares

belonging to this group show only latent inflammation, which does bring about clinical symptoms.

We can classify otitis media in infants as follows :

(1) Witmaack's otitis media neonatorum (also called plastic hyperplastic).

(2) Catarrhal and suppurative otitis media.

The latter group again according to the course of the disease in

(a) manifest otitis ;

(b) latent otitis ;

and according to its connection with the concurrent disease into

(a) primary ;

(b) secondary.

One school holds that the disease of the ear is the cause of infection of the gastro-intestinal system, others again deny the connection ; point out that there are many more cases of otitis media during the winter, and, on the other hand, of gastro-enteritis during the summer ; furthermore, there is the different bacteriological finding and the fact that operative treatment did not do away with alimentary disorders. The latter point, however, has been refuted by the experiences of the past few years. According to Logan Turner it is probable that the gastro-enteritis and the following dystrophias are primary and favour the infection of the middle ear. On the other hand, he points out the close relation between the acute pulmonary conditions, especially broncho-pneumonia, and otitis media. Leathart considers diarrhoea, vomiting and dehydration in infants to be caused very often by a latent oto-mastoiditis, the symptoms being brought about by the normal harmony between parasympathetic and sympathetic innervation being upset in favour of the former by an inflammation of the tympanic cavity and mastoid antrum. The cause of infection is frequently due to the infant being bottle-fed whilst lying on the back, to infected mucus passing through the eustachian tube while in this position.

The percentage of infants in which otitis media has been found varies with different authors. So, for instance, McConkey and E. C. Couper found an otitis in 14 per cent. of all hospitalized infants, Tobl in 43 per cent., not more than 3½ per cent. of whom had an affection of the ear on admission. I. E. Ebbs found in 238 infants with gastro-enteritis, an otitis in 81 per cent. of the cases.

The symptomatology of otitis media in infants is different from that of later age : loss of weight and gastro-intestinal symptoms which do not improve by the usual dietary measures come much to the foreground ; also there is usually an increased temperature as in older children and adults. Couper points out that vomiting and diarrhoea are the most

Contribution to the Question of Otitis Media in Infants

commonest symptoms of disease in infancy, whereas otitis and mastoiditis are only one of the many sources of parenteral infection. He stresses that an otitis in infancy might produce conditions nearly as serious as mastoiditis. The normal tympanic membrane in infancy shows certain differences according to age. In general one can say that it is grey, slightly dim, slightly less transparent than in later age; the cone of light is nearly always present except that in infants under 2 months of age it is sometimes missing. In the case of otitis, according to Ninger, the tympanic membrane becomes first dull, and the cone of light, and later the malleolar prominence, disappears. The changes of the drum appear, according to him, first in the pars flaccida. Later the colour changes into a yellowish or brownish tint, greyish-red or dirty red colour. The fact that spontaneous perforation does not occur so often with infants was known already long ago. Preysing explained it by constitutional differences. Witmaack considered it as the characteristic symptom of the latent otitis without re-infection or exacerbation. As a further explanation for that he mentioned the width of the eustachian tube and the ciliary epithelium which he found in the whole of the tympanum and often also in the antrum. Other authors stress the fact that at this age the tympanum does not form a single cavity and that it takes therefore a longer time until the amount of pus collected is big enough to cause a perforation. For the same reason, the pain caused by middle-ear inflammation in infants is less intensive than in bigger children and in adults, and therefore sensitivity of the ears to pressure is not a safe guide in infants under one year of age, although it might be pronounced in some cases.

During the past few years many authors in their publications have considered that the findings on the tympanic membrane do not reveal sufficient information and maintain that they are not important for diagnostic purposes, but are more inclined to go by the general condition of the infant. Although this last point must not be forgotten, I have been able to rely successfully on the otoscopic finding, taking into account its peculiarities at this age. Only in the later stages of otitis media (after a few days of discharge following myringotomy) were the changes of the drum in some cases not very helpful in revealing smaller retentions of pus, although there were many cases where this retention brought about a slight bulging and reddening, usually in the posterior superior quadrant.

About the indication for myringotomy there are still different views. There is, however, general agreement that it should be performed in cases of pathological changes of the tympanic membrane and in all doubtful cases. According to Wiskovsky the cone of light is only of minor importance and can be present with older infants even when there is an otitis media. According to Ninger, myringotomy is indicated in every case of the typical pathological changes of the tympanic membrane, and

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The percentage of infants in which otitis media has been found varies with different authors. So, for instance, McConkey and E. C. Couper found an otitis in 1.4 per cent. of all hospitalized infants, Tobl in 43 per cent., not more than $3\frac{1}{2}$ per cent. of whom had an affection of the ear only. I. E. Ebbs found in 238 infants with gastro-enteritis, an otitis in 81 per cent. of the cases.

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also in cases of uncertain finding. He considers, however, the presence of the cone of light as a certain sign that there is no otitis media. Tetera describes two cases where the drum, including the cone of light, was absolutely normal, but he found, nevertheless, pus in the antrum when performing mastoidectomy. Lemoyne, after his experiences with a few hundred cases, states that he never found an inflammation of the antrum without changes on the tympanic membrane. Couper relates 12 cases of otitis media in infants treated by penicillin without myringotomy, resulting in 11 of them being cured. The diagnostic value of myringotomy is also generally acknowledged. The normal tympanic membrane when myringotomy is performed, gives the feeling of pierced parchment, and does not bleed. The feeling of a soft, thickened or less elastic drum with bleeding of the margins of the cut is a certain sign of pathological changes. The fact that myringotomy is not automatically followed by discharge is no absolute proof that otitis media is not present. Le Mée describes the first stage of inflammation in which myringotomy is not followed by discharge and which he calls otosalpingitis. Couper states that discharge begins sometimes only after dehydration has been suppressed.

Survey of Cases

During the six months of the past autumn and winter, we treated, in close co-operation with pediatricists, 101 infants under one year of age in whom otitis media was diagnosed or suspected. All cases referred to were hospitalized, the great majority in the children's department of our hospital.

At the first examination I kept to the principle of performing myringotomy in every case where otoscopy revealed the slightest deviation from normal, i.e. besides the more obvious changes in every case where the tympanic membrane showed less lucidity or the cone of light was absent. Myringotomy was, however, not performed when the tympanic membrane was of normal appearance. I adopted this method after having performed myringotomy at the pediatricists' request in many cases with normal tympanic membrane, without having been able to find even once inflammatory changes of the middle ear. This point of view was also proved to be correct by our experiences with those of our cases where there was only unilateral otitis, and where myringotomy had been performed also on the other side with absolutely normal findings in the tympanic membrane. No clinical sign of otitis was found in any of these unaffected ears within a week of myringotomy. There are only two exceptions where at autopsy pus was found even in this ear (Nos. 11 and 61), but without any signs of mastoiditis. It is therefore necessary to attribute these two findings to a terminal otitis or *post-mortem* invasion of pus through the eustachian tube. That being the normal way of infection during lifetime,

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there is no reason why some of these cases should not be explained in the above way, especially where broncho-pneumonia and bronchitis were the main features of the disease. It would, however, not seem right to generalize and to explain too many of the positive *post-mortem* findings in this way, especially not where there were signs of mastoiditis or where the clinical examination of the ears before death was not thorough.

Sensitivity of the ear to pressure proved to be a very unreliable guide, also the other symptoms like movements of the head and movements of the hands towards the affected ears, etc., did not give reliable information in the majority of cases.

Of the total number of 101 cases there were 79, i.e. 78.2 per cent., where otitis media was found. In 6 cases the findings at myringotomy were absolutely normal and the original slight changes of the drum were attributed in 3 cases to the early age of the infants (1st-3rd month), in 1 case to a previous otitis media, and in 2 cases the slight injection of the drum round the manubrium did not prove to be caused by an otitis media. In the remaining 16 cases, i.e. 15.8 per cent., the otoscopic findings and the finding when myringotomy was performed (i.e. thickened, less elastic tympanic membrane with a dry middle ear), were attributed to a previous "otitis media neonatorum hyperplastica". In all these cases myringotomy was not followed by discharge and had no influence upon the further progress of the disease. Two of these cases ended fatally, in one autopsy did not reveal any infection of the ear, and in the second we attributed (because of the general clinical picture of the case, No. 71), the *post-mortem* findings of pus in the middle ear without signs of mastoiditis, to terminal or *post-mortem* invasion of pus.

An analysis of the 79 clinically diagnosed cases of otitis media shows :

- (1) Sex :

Males	..	..	..	..	..	..	..	..	47, i.e. 59.5%
Females	..	..	..	..	..	..	..	..	32, i.e. 40.5%
- (2) Age :

0-3 months	..	..	..	..	..	..	..	31, i.e. 39.2%
4-6 months	..	..	..	..	..	..	..	21, i.e. 26.7%
7-12 months	..	..	..	..	..	..	..	27, i.e. 34.1%
- (3) Localization :

Unilateral	..	..	..	..	..	..	..	19, i.e. 24.0%
Bilateral	..	..	..	..	..	..	..	60, i.e. 76.0%
- (4) Otitis media with spontaneous perforation 9, i.e. 11.4%
 Otitis media without spontaneous perforation 70, i.e. 88.6%
- (5) Cases with very slight changes of T.M. (only slight dullness and/or absence of cone of light) where, however, otitis media was found 43, i.e. 54.3%

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(6)	Cases which were evidently secondary ones (where it was evident from the clinical picture that the otitis occurred only as a complication in the later stage or as a complication of less importance)	17, i.e. 21.5%
	Cases where it was not possible to decide exactly whether the otitis media was primary or secondary, amongst which, however, the primary were quite numerous ..	62, i.e. 78.5%
(7)	Cases with broncho-pneumonia or other airborne infection besides otitis media	46, i.e. 58.2%
	Cases with severe gastro-intestinal symptoms	41, i.e. 51.9%
	Cases with slight gastro-intestinal symptoms	5, i.e. 6.3%
(8)	Result of treatment :	
	Cured	64, i.e. 81.0%
	Death after otitis had been cured	2, i.e. 2.6%
	Death from other organic lesions (according to clinical and autopsy findings) where otitis media played a minor role	8, i.e. 10.1%
	Death from otitis media and complications of O.M. (2 of these were seen only 24 hours before death)	5, i.e. 6.3%

Mastoidectomy was performed in 11 cases, i.e. 13.9 per cent. (8 times bilateral). There were 3 deaths amongst these operated infants, one case being complicated with meningitis and septicæmia, the second with severe toxicosis and dehydration, whilst the third was suffering from severe toxicosis and there was no positive finding when mastoidectomy was performed. Of these 11 cases, only one developed post-auricular œdema and this was an infant of 11½ months of age. Although we operated only after an average of 22 days, we achieved good therapeutic results, always taking into account the general condition of the infant.

The average number of myringotomies per treated ear was 1.8. In 3 cases (Nos. 12, 90 and 100) it was even 2.5, resulting in recovery without further operative interference. In quite a number of cases it proved useful to perform a control-myringotomy before discharging the infant as recovered. The average time of treatment was, in the uncomplicated cases, 14 days, in those complicated by mastoiditis, 5½ weeks.

It was possible to trace a favourable reaction after myringotomy in the great majority of cases. This was not present in cases of secondary catarrhal otitis, in cases complicated by mastoiditis and in cases of "otitis media neonatorum hyperplastica". This reaction appeared as a rapid decrease of temperature, increase in weight and improvement of the gastro-intestinal symptoms. Only in a few cases did the first myringotomy coincide with the beginning of penicillin therapy, so that it is not possible to state exactly whether it was due to the former. Taking, however, into account the reaction of the other cases on myringotomy, one can attribute the reaction to this. Surprisingly large was the

Contribution to the Question of Otitis Media in Infants

number of cases where discharge followed myringotomy within 24-48 hours, although when the incision was performed, no pus or fluid was seen (13 cases, i.e. 16.45 per cent.).

Penicillin therapy was, compared with the results obtained in older children and in adults, rather less effective and very slow in showing results, also sulphathiazole and sulphadiazine given for 6-7 days in the usual big dosage to nearly all of the treated cases, did not show the result to which we were accustomed with our older patients. That might possibly be taken as a proof that many of these cases are only secondary complications of gastro-enteritis. It is, however, necessary to attribute to them the same importance as they do deteriorate the general condition of these infants.

In 7 cases it was possible to follow up the development of otitis media by the change of otoscopic appearance from a normal to a pathological condition (Cases Nos. 1, 48, 50, 84, 85, 86, 100). This fact, together with the rest of the observations, confirmed the opinion that it is possible to rely on the otoscopic findings. I found also in many cases of bilateral otitis media, different otoscopic appearances which, when myringotomy was performed, proved to be in definite connection with the contents of the tympanic cavity.

As for prognosis, it was possible to prove the great importance of the positive reaction after the first myringotomy and also the unfavourable prognosis *quo ad anationem* of the whitish-grey, rather dull and stretched drums, which did not bulge. In the latter cases the suppurative process seemed to have been already of longer duration.

Summary and Conclusions

A survey of literature concerning the problem of otitis in infants is given with special reference to the symptomatology of the disease and the views about the changes observed on the tympanic membrane.

Experiences and results with 101 infants under 1 year of age are reported. On 93 of them myringotomy was performed because of very slight to moderate changes of the tympanic membrane, and because of their general condition. In as many as 78.2 per cent. acute otitis was diagnosed, in 15.8 per cent. the condition of the drum and the finding when performing myringotomy were attributed to a previous "otitis media neonatorum hyperplastica". In 3 cases the slight changes of the drum were probably due to the early age and in one to an earlier otitis. Attempts were made to divide the otitis into primary and secondary cases. Stress is being laid on the importance of the slight changes of the tympanic membrane in infantile otitis (dullness and loss of the cone of light) which proved to be a reliable guide in making a correct diagnosis.

(For References see page 230)

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No of admission	Age (mths)	Sex	History of gastro-intestinal symptoms	Other pediatric findings apart from ear	Objective findings in tympanic membrane	
					R	L
1 13391	5	M	o	Broncho-pneumonia L sin	Neg 8 days later slight redness in sup post quadrant	Lack of lustre and cone slight bulging and redness in sup post quadrant
2 12948	5	M	+	Broncho pneumonia Pharyngitis ac	Slight lack of lustre, no cone of light	Viz R
3 13106	1	M	++	o	Slightly darker slight lack of lustre, no cone	Bulging and reddening in ant superior quadrant
4 13907	8	F	o	Bronchitis and bronchiolitis	Neg	Slight pink tint, no cone of light
5 12930	3	F	o	Lues congenita furunculosis rhinitis	Reddening mal leolar prominence less visible	Lack of lustre, malleolar prominence less visible no cone of light
6 13376	2	M	Slight	Pyoderma	Drum grey, slightly dull No cone of light	Viz R
7 13924	9	F	—	Anæmia rachitis	Dull grey with slight injection	Dull grey, with very slight injection contours slightly less visible
8 14066	2	F	+	Influenza	Nil	Slight loss of lustre
9 13299	3	F	o	Acute bronchitis, acute rhinopharyngitis	Slight lack of lustre No cone of light	Slight lack of lustre Slight reddening, no cone of light
10 14048	2	F	++	Broncho pneumonia Enteritis	Slight lack of lustre No cone of light	Slight lack of lustre No cone of light
11 12550	2	M	+	Enterocolitis Septicæmia	Grey with very slight lack of lustre, normal cone of light	Dull grey, with slight reddening No cone of light
12 14088	2	F	++	Pyoderma broncho pneumonia colenteritis subchron	Slight lack of lustre No cone of light	Viz R
13 14431	10	M	—	Bronchitis ac rhinopharyngitis	Grey, bright with out cone of light	Viz R.
14 14033	5	M	o	o	Grey slight lack of lustre No cone of light	Viz R
15 15525	1	M	+	Broncho pneumonia bilat	Grey with slight pink tint No cone of light	Viz R
16 14770	4	F	—	o	Dull, red, thickened	Viz R
17 14258	2	M	—	Erythrodermia desquamativa	Dull without cone of light	Slight injection, bulging

Contribution to the Question of Otitis Media in Infants

Findings at first myringotomy		Duration of discharge (days)		No. of further myringotomies		Length of treatment (days) and result	Reaction after first or further myringotomy			Remarks
R	L	R	L	R	L		Temperature	Wt	Gastrointestinal symptoms	
Loss of elasticity	Pus in middle ear	7	12	1	1	18 cured	+	±	1	
Loss of elasticity	Loss of elasticity	12	7	—	—	17 cured	+	+	+	
Serous exudate	Pus	42 w i	35 w i	2	2	49 cured	+	+	+	Penicillin 0.28 mg/l u
—	Loss of elasticity	0	0	—	—	—	0	0	0	
Serous exudate	Serous exudate	11	11	—	—	14 cured	1	0	1	
Loss of elasticity	Loss of elasticity	0	0	—	—	—	0	0	0	
Mucopus	Loss of elasticity	14	14	1	2	14 cured	±	±	±	
—	Loss of elasticity	0	3	—	—	3 disch at parents request	+	+	+	
Loss of elasticity	Loss of elasticity	6	6	—	1	7 cured	±	+	1	
Loss of elasticity	Loss of elasticity	0	0	—	—	—	0	0	0	
Elastic tympanic membrane middle ear dry	Serous exudate	—	2	—	—	4 death	Transitory	0	0	First seen in 6th week of illness. Autopsy Otitis med supp lat utrique septicaemia enterocolitis
Loss of elasticity	Viz R	4	45	4	1	63 cured	+	+	+	Bact finding Pneu. monococcus I, II, IV Pseudomonas pyocyan corynebacterium diphtheroides
Thick pus	Loss of elasticity	4	9	1	—	12 cured	+	Slow	Slow	
Serous exudate	Viz R	2	2	—	—	2 disch on parents request	Not possible to assess			
Elastic tympanic membrane M ear dry	Viz R	0	0	—	—	—	0	0	?	
Pus	Mucopus	14 w i	12 w i	1	1	21 cured	1	+	+	
Serous exudate	Serous exudate	24	24	2	2	28 cured	0 after +	0 second +	1 1	

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	No of admission	Age (m'ths)	Sex	History of gastro intestinal symptoms	Other pediatric findings apart from ear	Objective findings in tympanic membrane	
						R	L
18	15253	3	F	+	o	Dull, thickened malleolar prominence not visible No cone of light	Reddening in ant sup quadrant
19	15450	2	M	+	o	Grey, dull, covered with slight amt of pus	Viz R
20	15491	11	F	o	Acute rhinopharyngitis	Bright grey, malleolar prominence well visible, no cone of light	Dull grey, malleolar prominence less visible, no cone of light
21	14919	1	M	o	Broncho pneumonia, rhinopharyngitis	Grey, slightly dark, without cone of light	Grey, dull, no cone of light
22	15422	4	F	+	Atrophia gravis	Dull, with light pink tint, no cone of light	Dull, slightly dark, no cone of light
23	15831	7	F	+	Rhinopharyngitis ac	Bright grey, no cone of light	Viz R
24	14171	2	M	+	Eczema	Reddened bulging in post half, partly covered with pus	Reddened, thickened, with perforation in post inferior quadrant
25	19445	6	F	o	Rachitis	Grey, with slight pink tint, no cone of light	Viz R
26	15965	2	M	++	Fixatio	Grey, dull, slightly darker, no cone of light	Grey, dull, no cone of light
27	16528	9	F	o	Rhinopharyngitis ac Bronchitis ac	Dull grey, with slight injection round manubrium, no cone of light	Bright grey, no cone of light
28	16923	1	M	o	o	Grey, slightly dull no cone of light	Viz R
29	16429	6	M	o	Meningo-encephalitis susp	Grey, dull, no cone of light, slight reddening of post sup quadrant	Grey, bright, with normal cone of light

Contribution to the Question of Otitis Media in Infants

Findings at first myringotomy		Duration of discharge (days)		No of further myringotomies		Length of treatment (days) and result	Reaction after first or further myringotomy			Remarks
							Tem perature	Wt	Gastro intestinal symp toms	
R	L	R	L	R	L					
Serous exu date	Serous exu date	50 w i	53 w i	3	3	31 months cured	o	+	1	Penicillin 1 25 ml u. 32nd day mastoidectomy dx Small amt of pus in antrum
Pus	Pus	14	14	—	1	35 cured	o	o	o	Penicillin 1 35 ml u 10th day bilat mas toidectomy and R periauricular abscess found
—	Loss of elasticity	o	o	—	—	—	o	o	o	
Serous exu date	Serous exu date	14	9	—	—	18 cured	±	o	o	Otitis secondary
Serous exu date	Loss of elasticity	8	—	1	1	12 death	o	o	±	Otitis secondary 3 days after otitis was cured death occurred Autopsy Colenteritis catarrh gravis sub ac pedatrophia excessiva
Pus	Pus	2	2	—	—	7 cured	+	+	+	Readmitted 3 weeks later Middle ear found to be dry
Pus	—	5	10	2	1	11 cured	i	o	1	Otitis secondary
Loss of elasticity	Viz R	o	o	—	—	—	o	o	o	
Serous exu date	Pus	2	5	1	—	5 death	o	o	o	Otitis secondary Autopsy Colenteritis catarrh ac toxicosis otitis media catarrhalis lat utroque
Serous exu date	Loss of elasticity	14 w i	14 w i	2	2	35 death	+	+	1	17th day 1st signs of meningitis 18th 20th day resp mastoidectomy performed pus in cells and antrum Bact Pneumococcus I, II IV Penicillin 3 15 ml u Autopsy Otitis med supp 1 utroque septicaemia meningitis purul pyocephalus int
Elastic tympanic membrane Mid ear dry	Viz R	o	o	—	—	—	o	o	o	
Small amt of pus	—	1	—	—	—	1 death	o	o	o	First seen one day before death Otitis secondary Autopsy Sclerosis tuberosa, colitis catarrhalis otitis media supp peracta dx

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	No of admission	Age (in this)	Sex	History of gastro-intestinal symptoms	Other pediatric findings apart from ear	Objective findings in tympanic membrane	
						R	L
30	16622	3	F	+	Vitium cordis congenitum Atrophia gravis	Grey, slightly dull, no cone of light	Dull grey, thickened with perforation, covered with pus
31	17191	2	F	o	Rhinopharyngitis	Grey, slightly dull no cone of light	Viz R
32	17324	—	I	o	Diffuse bronchitis	Grey, slightly less bright, no cone of light	Viz R
33	16514	10	M	+	Morbus Lee Huebner Herli	Grey, slightly less bright, no cone of light	Grey, slightly less bright, no cone of light
34	17556	11	M	o	Pneumonia, lobum inf lat sin	Grey, slightly less bright, malleolar prominence well visible, cone of light dim and small	Grey, slightly less bright, malleolar prominence well visible, no cone of light
35	17503	8	M	o	Pyelitis	Slight reddening, bulging in post half	Bright grey, with normal cone of light
36	17625	9	M	o	Rhinopharyngitis et bronchitis ac	Grey, slightly darker, no cone of light	Bright grey, with normal cone of light
37	16945	1	M	++	Broncho-pneumonia, pemphigus	Grey, slightly dark, no cone of light	Viz R
38	17708	8	M	o	Rhinopharyngitis, Bronchitis, ac	Bright grey, with normal cone of light, slight injection round manubrium	Viz R
39	18029	3	M	o	Broncho pneumonia	Bright grey, malleolar prominence well visible, normal cone of light	Dark grey, with perforation covered with pus
40	18237	5	M	o	Rhinopharyngitis	Bright grey, no cone of light	Viz R
41	18172	11½	M	+	Broncho-pneumonia lat sin	Dull grey, with slight reddening in upper sup quadrant, no cone of light	Viz R
42	16591	4	F	+	St post oper Ramstedt	Grey, dark, malleolar prominence less visible, covered with pus Perf not visible	Grey, bright no cone of light
43	17943	2	F	—	Broncho-pneumonia, empyema	Grey, bright, with normal cone of light	Grey, bright, no cone of light, malleolar prominence well visible

Contribution to the Question of Otitis Media in Infants

Findings at first myringotomy		Duration of discharge (days)		No. of further myringotomies		Length of treatment (days) and result	Reaction after first or further myringotomy			Remarks
R	L	R	L	R	L		Temperature	Wt	Gas tro intestinal symp toms	
Serous exudate	—	9	9	—	—	9 death	i	o	±	Autopsy Otitis media supp., colenteritis catarrhalis
Loss of elasticity	Loss of elasticity	21	Only 3 days before open	1	—	61 cured	1	+	1	Penicillin 0.75 ml u 21st day bilat op R periantral abscess, left granulations in cells and antrum
Thick pus	Thick pus	7	14	1	1	14 cured	+	o	1	
Small amt of mucopus	Pus	30	30	1	1	35 cured	1	+	1	Penicillin 0.4 ml u 4 mths later recidive
Loss of elasticity	Pus	o	2	1	2	7 cured	+	o	i	Otitis secondary
Pus under pressure	—	5	—	1	—	7 cured	+	+	1	
Loss of elasticity	—	o	—	—	—	—	o	o	1	
Tympanic membrane elastic, mid ear dry	Loss of elasticity, mid ear dry	o	o	—	—	—	o	o	o	
Tympanic membrane with normal elasticity, mid ear dry	Viz R	o	o	—	—	—	1	o	1	
—	—	—	9	—	—	14 cured	—	—	—	
Thickened, less elastic	Mucopus	o	10	1	—	10 cured	±	+	1	
Serous exudate	Pus	7	7	—	—	7 cured	+	±	+	Penicillin 0.2 ml
Mucopus	Loss of elasticity	28	28	1	1	30 cured	o	o	o	Penicillin 0.2 ml
—	Mid ear dry	o	o	—	—	—	o	o	o	

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	No of admission	Age (m'ths)	Sex	History of gastro-intestinal symptoms	Other pediatric findings apart from ear	Objective findings in tympanic membrane	
						R	L
44	18219	3	M.	o	Rhinopharyngitis, Bronchitis, Tetania	Grey, dull, no cone of light	Viz R.
45	18011	3	M.	o	Bronchitis et rhinopharyngitis	Grey, bright, with normal cone of light	Grey, thickened, slightly dull, no cone of light
46	504	4	M.	o	Broncho pneumonia bil.	Grey, with slight injection, slight bulging of posterior half	Grey, with slight injection, no cone of light
47	18234	3	F.	+	Broncho pneumonia lat. dx.	Slight reddening, malleolar prominence less visible	Grey, dull, not transparent, covered with pus, perforation not visible
48	340	3	M.	++	Rhinopharyngitis	Grey, bright, normal cone of light. 4 days later: grey, dull, with slight injection in sup. post quadrant	Grey, slightly reddened
49	648	6	M	+	Rhinopharyngitis et bronchitis	Grey, slightly dull, no cone of light	Viz R
50	97	4	F.	±	Tonsillitis ac. Bronchitis	Grey, bright, normal cone of light. 7 days later: slight reddening of post half	Grey, bright, normal cone of light. 5 days later: slight reddening of post half
51	403	3	F.	o	Pyoderma	Grey, with slight injection, no cone of light	Viz R.
52	654	5	M	o	Pyoderma	Grey, with slight pink tint, no cone of light	Viz. R.
53	17597	4	M	±	Broncho pneumonia	Grey, bright, no cone of light	Viz R
54	1466	6	M	o	Broncho pneumonia, tonsillitis ac., pyoderma	Grey, dull, covered with pus, perforation in post inf quadrant	Reddening and bulging in post sup quadrant
55	1464	6	F	-	Rhinopharyngitis	Grey, slightly dull, malleolar prominence less visible, no cone of light	Grey, slightly dull, malleolar prominence well visible, no cone of light

Contribution to the Question of Otitis Media in Infants

Findings at first myringotomy		Duration of discharge (days)		No of further myringotomies		Length of treatment (days) and result	Reaction after first or further myringotomy			Remarks
R	L	R	L	R	L		Tem perature	Wt	Gas tro-intestinal symp toms	
Loss of elasticity	Loss of elasticity	0	0	1	—	—	±	±	1	
—	Loss of elasticity	0	0	—	—	—	0	0	1	
Pus	Pus	14	14	1	2	18 death	0	0	1	Penicillin 1.13 mil u Antrostomy L. peri-antral abscess Bact findings Pneumococcus I II IV Autopsy. Otitis + mastoiditis purul praecipue I dx toxicosis gravis colenteritis catarrhalis
Pus	No retention of pus noticed	1	1	—	—	1 death	First seen on day of death			Autopsy Otitis med supp I utroque toxicosis colenteritis catarrhalis degeneratio hepatis lipom
Loss of elasticity	Loss of elasticity	10	28	2	2	49 cured	Transitory	0	0	Penicillin 0.55 mil u 21st day 6 lat mas to dectomy periantal abscesses and pus in adjoining cells Bacteriol Staphylococcus aureus
Serous exudate	Pus	16 w i	17	1	1	27 cured	+	+	+	
Loss of elasticity	Serous exudate	7 w i	2	1	—	17 death	0	0	0	Otitis secondary Autopsy Toxicosis colenteritis haemorrh subac, otitis media supp lat utroque degeneratio hepatis lipom broncho pneumonia
Serous exudate	Serous exudate	1	1	—	—	3 cured	1	+	1	Otitis secondary Findings in membrana tympani rapidly improved
Pus	Pus	21	3	2	—	24 cured	+	+	1	Penicillin 0.6 mil u
Tympanic membrane less elastic nud ear dry	Viz R	0	0	—	—	—	0	0	1	
—	Pus	45	3	—	—	49 cured	0	+	1	Penicillin 0.6 mil u Bacteriol findings Staphylococcus aureus
Pus	Serous exudate	4	1	1	—	7 cured	1	1	+	

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	No of admission	Age (m'ths)	Sex	History of gastro intestinal symptoms	Other pediatric findings apart from ear	Objective findings in tympanic membrane	
						R	L.
56	814	6	M.	+	Broncho pneumonia, tonsillitis ac., pyoderma	Grey, less transparent, dim, slight injection round the manubrium	Viz. R
57	463	8	F.	+	Broncho-pneumonia bil	Grey, dull, with slight injection round manubrium, no cone of light	Grey, dull, malleolar prominence less visible
58	1478	11	M.	o	Spasmodic	Grey, bright, with slight reddening in ant. sup quadrant, no cone of light	Grey slightly dull, malleolar prominence well visible, no cone of light
59	157	8	F.	+	Pertussis, tetania	Greyish red, malleolar prominence less visible	Viz. R.
60	365	1½	F.	+	Influenza, broncho pneumonia	Grey, dull, thickened, without cone of light	Grey, less lurid, without cone of light
61	3049	6	F.	o	Pertussis, broncho-pneumonia	Grey, bright, with normal cone of light	Dark grey, thickened with tubal perforation, covered with pus
62	1476	3	F.	+	o	Grey, dull, with slight reddening and bulging in sup. post. quadrant, no cone of light	Grey, dull, without cone of light
63	655	6	F.	±	Broncho pneumonia	Grey, bright, with normal cone of light	Grey, dull, without cone of light
64	1254	6	F.	o	Broncho pneumonia bil	Grey, slightly dull, no cone of light	Viz R
65	1706	3	M	+	Broncho pneumonia bil	Grey, slightly dull, no cone of light	Viz R
66	1989	11	M	-	Broncho-pneumonia bil	Grey, slightly dull, malleolar prominence well visible, no cone of light	Viz. R.
67	2026	1	M	-	Broncho-pneumonia	Grey, slightly dull, without cone of light	Viz R

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Findings at first myringotomy		Duration of discharge (days)		No of further myringotomies		Length of treatment (days) and result	Reaction after first or further myringotomy			Remarks
R	L	R	L	R	L		Temperature	Wt	Gastrointestinal symptoms	
Serous exudate	Loss of elasticity	0	0	—	—	7 death	0	0	0	Otitis secondary Penicillin 0.65 mil u Autopsy Toxicosis colenteritis otitis media supp 1 sin Thrombosis sin sigmoidalis et sigmoidalis 1 dx, encephalomalacia hemispher utrique (caused most probably by penicillin therapy)
Loss of elasticity	Mucopus	0	12 w 1	—	3	14 cured	+	+	+	Penicillin 0.9 mil u
Pus	Pus	4	4	—	1	7 cured	1	+	1	
Pus	Pus	5	5	—	—	7 cured	+	?	+	Penicillin 0.3 mil u
Mucopus	Loss of elasticity	12	12	—	—	12 death	+	?	1	Penicillin 1 mil u 11th day bilateral mastoidectomy no pus or mucus found Autopsy Colenteritis partium ulcer toxicosis broncho-pneumonia
Membrana tympani elastic, middle ear dry	No retention	0	10	—	1	14 death	0	?	1	Penicillin 1.8 mil u Autopsy Pneumonia pul utrique colenteritis cat ac sec, pedatrophia gravis otitis media supp praecip 1 dx
Pus	Pus	46 w 1	25 w 1	6	4	3 months w 1 cured	+	+	0	Penicillin Beginning of 3rd month bilateral mastoidectomy small amount of pus in left antrum cells rather soft
—	Less elastic middle ear dry	0	0	—	—	—	—	—	—	3 months previous otitis
Serous exudate	Pus	14	14	—	—	17 cured	+	±	1	Bact findings Staphylococcus albus
Thickened less elastic membrane	Loss of elasticity	0	0	—	—	—	0	0	0	
Pus	Pus	14	14	1	1	14 cured	+	+	+	Penicillin 0.5 mil u
Serous exudate	Loss of elasticity	0	0	—	—	5 cured	±	+	+	

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	No of admission	Age (mths)	Sex	History of gastro-intestinal symptoms	Other pediatric findings apart from ear	Objective findings in tympanic membrane	
						R	L
68	2006	7	F.	+	Tracheo-bronchitis, spasmodophilia	Dull grey, with slight pink tint, without cone of light	Dull grey, without cone of light
69	2119	1	M	+	Intoxicatio aliment Broncho pneumonia	Dull grey, without cone of light	Viz R
70	2327	8	M.	o	Rhinopharyngitis et bronchitis ac	Dull grey, without cone of light	Grey, with pink tint, without cone of light
71	1698	3	M	±	Pertussis Broncho-pneumonia	Dull grey, without cone of light	Bright grey, lucid, with normal cone of light
72	1756	3	M	+	Enteritis ac	Dull grey, slightly darker, without cone of light	Viz R
73	2488	7	M.	o	Influenza	Grey, quite bright, without cone of light	Grey, dull, thickened appearance, no cone of light
74	2490	2	M	+	Broncho pneumonia	Grey, in upper posterior quadrant, reddened, slightly bulging	Grey, with pink tint, without bulging, no cone of light
75	2099	3	M	+	Broncho pneumonia	Grey, slightly dull, without cone of light	Viz R
76	2555	6	M	+	Acute tonsillitis	Grey, slightly darker, with pink tint, without cone of light	Bright grey, with normal cone of light
77	2597	3	M	+	Rhinopharyngitis, bronchitis	Bright grey, with normal cone of light	Grey, less bright, without cone of light
78	2742	3	F.	±	Broncho-pneumonia bil	Grey, without cone of light	Dull grey, without cone of light
79	2927	3	M	o	Rhinopharyngitis	Grey, with slight reddening, bulging in sup ant quadrant	Thickened, dull grey, with perforation in post inf quadrant covered with pus
80	2976	8	F	±	Broncho-pneumonia	Bright grey, lucid, with normal cone of light	Grey, slightly dull, without cone of light
81	2599	5	F.	o	Influenza, eczema faciei	Dull grey, without cone of light	Viz R

Contribution to the Question of Otitis Media in Infants

Findings at first myringotomy		Duration of discharge (days)		No. of further myringotomies		Length of treatment (days) and result	Reaction after first or further myringotomy			Remarks
R	L	R	L	R	L		Temperature	Wt	Gastrointestinal symptoms	
Loss of elasticity	Loss of elasticity	0	0	—	—	—	0	0	0	
Mucopus	Serous exudate	25 w 1	25	3	1	25 death	0	1	0	Secondary otitis. Penicillin 0.17 ml u Autopsy. Colitis ulcer perforativa, peritonitis incip, broncho pneumonia peracta
Serous exudate	Membrana tympani thickened	5	0	—	—	7 cured	+	±	+	
Loss of elasticity Mid. ear dry	—	0	0	—	—	— death	0	0	0	When seen 1 and 2 days after myringotomy opening patent, no discharge Autopsy Colenteritis ac, toxicosis, otitis media praecip lat sin
Serous exudate	Serous exudate	5	5	—	—	7 cured	+	+	+	Otitis secondary
Middle ear dry	Pus	—	11	—	—	14 cured	+	+	±	Otitis secondary
Serous exudate	Serous exudate	0	0	—	—	7 cured	0	0	0	Obvious improvement of otoscopic picture after myringotomy
Serous exudate	Tympanic membrane elastic Middle ear dry	2	0	—	—	7 cured	—	—	—	
Tympanic membrane elastic Middle ear dry	—	0	—	—	—	—	—	—	—	
—	Tympanic membrane elastic Middle ear dry	—	0	—	—	—	—	—	—	
Loss of elasticity	Loss of elasticity	0	0	—	—	—	—	—	—	
Mucopus	—	3	4	—	—	7 cured	0	0	0	
—	Serous exudate	—	20	—	—	21 cured	+	+	+	Penicillin 0.1 ml u Bact findings streptococcus alfa haemolyt. Pneumococcus I, II, IV
Thickened less elastic	Thickened less elastic	0	0	—	—	—	0	0	0	

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	No. of admission	Age (m'ths)	Sex	History of gastro-intestinal symptoms	Other pediatric findings apart from ear	Objective findings in tympanic membrane	
						R.	L.
82	3287	3	F.	o	Bronchitis et bronchiolitis	Whitish grey, stretched, malleolar prominence less visible, no cone of light	Viz R
83	3342	9	M.	±	Influenza, tonsillitis	Grey, slightly dull, no cone of light	Viz. R.
84	3349	5	M.	o	Influenza, rhinopharyngitis	Dull grey, malleolar prominence well visible, no cone of light	Bright grey, with cone of light, 3 days later: less lucid, slightly pink, cone of light disappeared
85	3389	3	F.	±	Influenza, bronchopneumonia	Grey, slightly dull, normal cone of light. 7 days later: slightly pink, cone of light disappeared	Viz. R.
86	3413	5	M.	++	Influenza	Pinkish grey, malleolar prominence well visible, no cone of light	Grey, lucid, with cone of light 3 days later: dull cone of light disappeared
87	3404	2	M	+	o	Whitish grey, dull, malleolar prominence less visible, no cone of light	Viz R.
88	3542	7	M	±	Rhinopharyngitis, bronchitis	Dull grey, without cone of light	Dark grey, without cone of light
89	3850	7	F	++	Colitis acuta gravis	Grey slightly dull, without cone of light	Viz. R
90	4121	7	M	o	Influenza	Dull grey, without cone of light	Viz R
91	4187	9	M	o	Tonsillitis, purpura	Grey, in posterior sup quadrant, slightly reddened	Bright grey, lucid, with normal cone of light
92	4590	2	M	++	Gastro-enteritis	Dull grey, dark in post. part, slightly pink. No cone of light	Grey, slightly less lucid, no cone of light
93	4608	6	M	+	o	Dull grey, without cone of light	Dull grey, darker, without cone of light

Contribution to the Question of Otitis Media in Infants

Findings at first myringotomy		Duration of discharge (days)		No of further myringotomies		Length of treatment (days) and result	Reaction after first or further myringotomy			Remarks
R	L	R	L	R	L		Temperature	Wt	Gas tro intestinal symptom	
Pus	Pus	30 w 1	31 w 1	2	2	61 cured	±	0	1	Penicillin 0.3 mil u Bilat mastoidectomy '28th day) pus in antra, cell walls partly destroyed, filled with pus Bacteriol Streptococcus beta haemolyt Pneumo coccus I, II IV
Serous exu date	Drum elas tic, middle ear dry	1	—	—	—	7 cured	+	+	1	Otitis secondary
Pus	Serous exu date	10	1	—	—	10 cured	+	0	1	
Pus under pressure	Thin pus	10	10	—	—	12 cured	1	+	+	
Serous exu date	Serous exu date	2	1	—	—	7 cured	+	++	++	
Serous exu date	Pus	70 w 1	70 w 1	4	—	2½ months cured	Transitory			Penicillin 1 mil u 18th day bilateral mastoidectomy Pus in antra right pus in zygomatic cells, left pus in cells of tip Bacteriol Pneu mococcus I, II IV
Serous exu date	Serous exu date	2	1	—	—	4 cured	+	0	+	Otitis secondary
Tympanic membrane less elastic ear dry	Tympanic membrane less elastic, ear dry	0	0	—	—	— death	0	0	0	Autopsy Toxicosis colitis ac gravis de generatio organorum praecip hepatis gravis (no sign of otitis or mastoiditis)
Thickened, less elastic	Pus	14	14 w 1	3	4	18 cured	+	+	1	
Mucopus	—	2	—	—	—	5 cured	+	1	1	
Serous exu date	Loss of elas ticity	11	0	2	1	21 death later	1	1	0	Otitis secondary After 3 weeks no further sign of otitis Autopsy Colenteritis catar rhialis, toxicosis, pneu monia peracta
Serous exu date	Serous exu date	14 w 1	7 w 1	2	1	21 cured	0	0	0	Main therapeutic effect by penicillin 0.1 mil u

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	No of admission	Age (mths)	Sex	History of gastro intestinal symptoms	Other pediatric findings apart from ear	Objective findings in tympanic membrane	
						R	L
94	5049	6	M	+	o	Grey, with slight reddish tint, malleolar prominence less visible, no cone of light	Dull grey, without cone of light
95	5058	4	F	o	Broncho pneumonia lat dx	Grey, with pink tint, malleolar prominence less visible, no cone of light	Viz R
96	5230	2	F	-	Broncho pneumonia, rhinitis purulenta	Thickened, dull grey, covered with pus, perforation not visible	Viz. R.
97	6441	8	F	o	o	Pinkish grey, bulging, without cone of light	Dull grey, malleolar prominence well visible, no cone of light
98	5038	11½	F.	±	o	Dull grey, thickened appearance, malleolar prominence less visible, no cone of light Retroauricular oedema with fluctuation	Grey, lucid, with normal cone of light
99	4312	10	M	o	Tonsillitis	Grey, slightly dull, without cone of light	Viz R
100	4129	7	M	+	Pharyngitis, bronchitis, rachitis, anaemia	Bright grey, malleolar prominence well visible no cone of light 14 days later t m dull	Dark grey, malleolar prominence well visible, no cone of light
101	5885	11	M	o	Bronchitis	Grey, slightly dull, without cone of light	Viz R

1 = irrelevant

Contribution to the Question of Otitis Media in Infants

Findings at first myringotomy		Duration of discharge (days)		No. of further myringotomies		Length of treatment (days) and result	Reaction after first or further myringotomy			Remarks
R	L.	R.	L.	R.	L.		Temperature	Wt.	Gastro-intestinal symptoms	
Mucopus	Loss of elasticity	10 w i	10 w.1	1	1	14 cured	+	+	+	
Small amt. of serous fluid	Small amt. of serous fluid	0	0	—	—	5 cured	±	±	1	Otitis secondary
Serous exudate	—	6	6	—	—	6 death	0	0	0	Bacteriol findings : nose : diphtheria and staphylococcus aureus ear : streptococcus beta hæmolyt. Penicillin 0.15 mil. u Autopsy Bronchopneumonia l inf, lat dx., septicæmia, tracheitis et bronchitis purulenta, otitis med supp lat. utroque
Mucopus	Serous exudate	5	5	—	—	7 cured	1	0	1	
Pus	—	7	—	—	—	28 cured	1	0	1	2nd day right mastoidectomy : fistula through bone covering antrum, periantral abscess, pus in cells, bacteriol findings Staphylococcus aureus alfa hæmolyticus
Serous exudate	Serous exudate	6	6	—	—	7 cured	+	±	1	
Tympanic membrane elastic, ear dry. Serous exudate	Serous exudate	2	5	2	3	18 cured	1	1	±	Otitis secondary Penicillin 0.1 mil u
Loss of elasticity	Serous exudate	26	14	1	—	29 cured	+	0	1	Bacteriol findings . Staphylococcus aureus beta hæmolyt corynebacterium diphtheroides

w i =with intervals

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THE TURNING TEST WITH SMALL REGULABLE STIMULI

III. THE ADVANTAGES OF CUPULOMETRIA OVER THE CLASSIC TECHNIQUE OF BÁRÁNY

By J. J. GROEN and L. B. W. JONGKEES*

As has been explained in some previous papers, it is possible to examine the function of the semicircular-canal-organ by observing the after-reactions after small stimuli (Groen and Jongkees, van Egmond, Groen and Jongkees, Hulk and Jongkees).

At that time we already considered this method superior to the classic technique of Bárány on account of the following reasons :

The examination according to Bárány provides us with data on the function of the semicircular canals (in combination with the counterbalancing activity of the central nervous system) on one special point. The acceleration caused by this method at the beginning of the test covers the effect of the deceleration at stopping. In this way the given stimulus is not known quantitatively. We are able to show, in this paper, that the examination of Bárány is not without danger for the function of the examined cupula system. Already Fearing and Mowrer have pointed out that repeated turning tests of the order of magnitude as used by Bárány decreased the duration of the after-nystagmus in their test animals and that this decrease might last many weeks or even months.

The turning test, as used in our clinic—the cupulometria (van Egmond, Groen and Jongkees)—is actuated by the following motives :

- (1) The given stimulus should be pure, without any overlapping of the acceleration at the beginning and the stopping.
- (2) The stimulus must be quantitatively known.
- (3) The stimulus must be harmless ($60^{\circ}/\text{sec.}$ and less).
- (4) The reaction on stimulation of various intensity must be registered both on an objective (nystagmus) and a subjective (sensation) scale.

In this way we expected to get an impression of the action of the semicircular canal in its total physiological activity sphere. To effect this purpose we proceeded in the following way :

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The patient is placed on a turning chair in such a way that the plane of rotation coincides with that of one pair of canals, i.e. the two horizontal canals; the left anterior vertical canal and the right posterior canal; the right anterior vertical canal and the left posterior canal. This chair is given a constant angular velocity of about $15^\circ/\text{sec.}$ which (according to Veits) is obtained by accelerating below the threshold of rotatory sensation. If nevertheless some small sensations of rotating should be caused, we turn on with constant angular velocity till these sensations have vanished completely and in any case for at least one to two minutes. After this the rotating chair is stopped suddenly (1 to 2 seconds). The patient is instructed to indicate the moment on which the sensation of turning has stopped. At the same time the duration of the after-nystagmus is determined behind Frenzel's glasses. After that the duration of both after-reactions is measured for smaller impulses (i.e. stopping from lower angular velocity) both for turning clockwise and anti-clockwise. This is continued till the threshold is reached on which a sensation of rotating is only just perceived. This threshold lies at about $2.5^\circ/\text{sec.}$ normally. After that the duration of the after-reaction caused by stronger stimulation is examined up to about $60^\circ/\text{sec.}$ or occasionally, if an unusually unsensitive labyrinth is found, up to $90^\circ/\text{sec.}$ (rotating time over 360° 4 seconds). This last stimulus is still twice as small as the stimulation according to Bárány, i.e. 10 rotations within 20 seconds giving a stimulus of more than $180^\circ/\text{sec.}$ The magnitude of the impulse can be measured easily by dividing the covered angle (to be read in degrees on a scale painted on the floor round the rotating chair) by the number of seconds the chair needs to cover this angle at constant angular velocity. If we register the obtained data graphically in a curve—on the abscissa the impulse on a logarithmic scale in degrees/sec., on the ordinate the accessory time of the after-reaction in seconds—a *cupulogram* originates. Such a cupulogram consists of four lines, two for the nystagmus and two for the sensation, i.e. in each instance one for stopping from a clockwise rotation and one for stopping from an anti-clockwise rotation.

In normal cases the clockwise and anti-clockwise curves are identical, however the curves for nystagmus and sensation are never similar, or at least very seldom.

The shape of the normal cupulogram has been described in detail in a previous paper (Hulk and Jongkees). Now we will show the influence of the turning test according to Bárány, using the *cupulograms* of normal test persons before and after this test.

For this purpose we took the cupulograms of a number of completely normal men and women, who never had any complaints of their ears or vestibular organs nor any abnormalities at accurate examination. These cupulograms turned out to be normal both for nystagmus and sensation.

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The curves for turning clockwise and anti-clockwise were identical. After this they were submitted to the Bárány test (three times rotated clockwise and three times anti-clockwise, 10 rotations in 20 seconds), and here also normal data were found, similar after turning clockwise and anti-clockwise.

On taking a new cupulogram this appeared to be changed both for the nystagmus and for the sensation. The sensation cupulogram is displaced to the right, that means that the sensitivity is diminished. The nystagmus cupulogram is sometimes displaced towards greater sensitivity. Besides the inclination of both nystagmus and sensation cupulogram is diminished, i.e. the curve has a less steep course, that means that the duration of the after-nystagmus or after-sensation after identical stimuli is shorter now than before the Bárány test. Immediately after the Bárány test this is obvious, but even after a few days it can be demonstrated easily in most instances. In some cases the curves for turning clockwise and anti-clockwise are no longer identical. This may be the result of the fact that on the rotating chair the stimulus in one sense was stronger than in the other. Fearing has shown that repeated turning tests with strong stimuli in one direction diminish the after-reactions depending on turning in this direction, but do not influence the reactions after turning in the opposite direction.

Figures 1 and 2 show clearly the changes which may be caused in a cupulogram by a Bárány test. The damaging influence on the cupula is unmistakable in normal subjects. Now if this happens in normal people, we ought to be very afraid of damaging an already diseased labyrinth. Such damage might be permanent.

Even though we do not yet know the consequences of the changes of the cupulogram, in any case we should rather use a technique of examining which does not alter the function of the examined organ.

Cupulometria does not effect such a change if we only do not surpass a stimulus of $60^{\circ}/\text{sec}$. Occasionally we saw a small decrease of the *sensation* time caused by small stimuli after the use of strong stimuli (72 or $90^{\circ}/\text{sec}$.), from which it is evident that we already used too great stimuli.

Summarizing shortly, we consider the advantages of the cupulometria over the Bárány technique to be the following :

- (1) An impression is obtained on the function of the semicircular canals on different points of sensitivity.
- (2) The given stimulus is exactly known.
- (3) The given stimulus is regulable.
- (4) The given stimulus is harmless.
- (5) A comparison between sensation and nystagmus is possible.
- (6) Also when a spontaneous nystagmus exists, a further examination is possible by the sensation cupulogram.

- (7) Even very ill patients may be examined, if only they are transportable and allowed to sit upright.
- (8) Finally the technique of Bárány is not without danger for the function of the vestibular organ, and therefore we consider the technique with small regulable stimuli a much better method than that of Bárány.

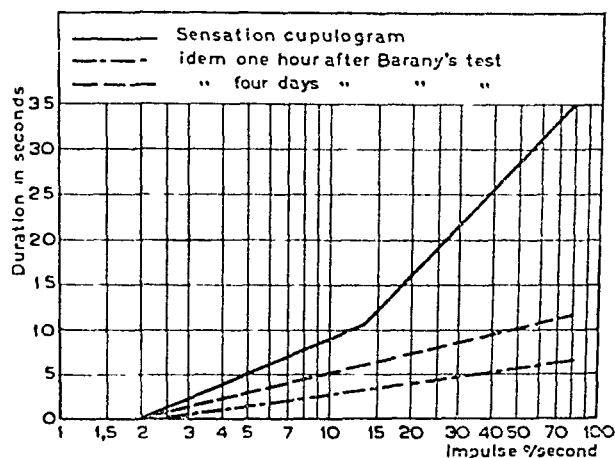


FIG. 1.

The influence of the turning test according to Bárány on a normal sensation cupulogram.

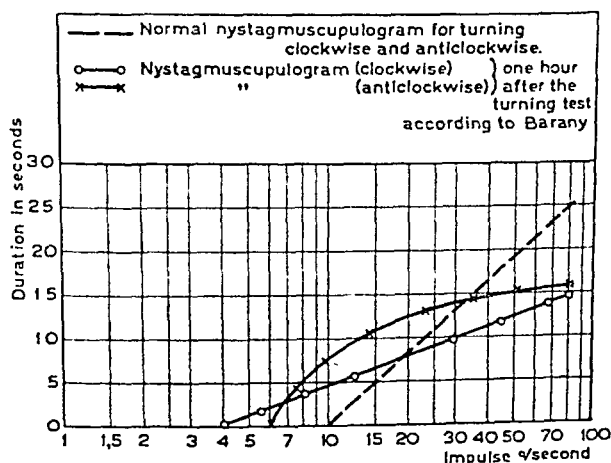


FIG. 2.

The influence of the Bárány test on a normal nystagmus cupulogram.

The Turning Test with Small Regulable Stimuli

Summary

The turning test with small regulable stimuli (cupulometria) has many advantages over the classic Bárány test

By this method it could be demonstrated that the examination according to Bárány (10 times rotated in 20 seconds) damages the function of the vestibular organ, even after one examination

The cupulometria is preferable to the Bárány technique because the stimulus is regulable harmless and exactly known In this way even seriously ill persons may be submitted to the examination

Also, an impression of the function of the semicircular canals in its total sphere of physiological activity is obtained

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IV. THE CUPULOGRAM OBTAINED BY SUBJECTIVE ANGLE ESTIMATION

By J. J. GROEN and L. B. W. JONGKEES*

As has been explained in some previous papers (van Egmond, Groen and Jongkees, Hulk and Jongkees, Groen and Jongkees) it is possible by administering a number of rotatory stimuli of various strengths to obtain a diagram which gives a good impression on the function of the semicircular canal system in its total physiological sphere. To make such a diagram it is possible to make use of the duration of both after-nystagmus and after-sensation (nystagmus cupulogram and sensation cupulogram) at the turning test, after subliminal acceleration at the beginning and abrupt stopping at the end.

There is another method at our disposal to obtain an impression on the function of the cupula in a very short time by using a very subjective technique. However, this method asks too much of the introspective observation of the examined subject to be usable for all patients. If, however, the patient is able to give us the information which we need, we get a very fine check on the curve obtained in the normal way. The point in this instance is to follow exactly the subjective angular velocity during the after-sensation. In this way we learn the sensation at every situation of the stimulation quantitatively. Essentially we get in a continuous line those data which we try to obtain point by point in cupulometria.

The test is performed in the following way: The subject is subjected to a known stimulation. A rotatory sensation (after-sensation) is caused and the patient gets the impression of turning round with a definite angular velocity. We ask him to indicate when he believes to have been rotated 360° , 180° or 90° as far as possible, until he stops. He indicates this last point also. We also determine his threshold for angular impulses in the normal way (*loc. cit.*) and with those two experiments it is possible to build up the whole cupulogram. Let us for instance suppose that a subject has been subjected to the influence of an impulse of $60^\circ/\text{sec.}$

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After three seconds he has the impression of having covered 180° . The average velocity is $60^\circ/\text{sec}$ at $1\frac{1}{2}$ seconds after the stopping. The next 180° need 5 seconds to be passed. The average velocity is $36^\circ/\text{sec}$ at $5\frac{1}{2}$ sec ($3 + 5/2$ sec). The next 90° are covered in his mind in 10 seconds, average velocity $9^\circ/\text{sec}$ at 13 sec ($3 + 5 + 10/2$ sec). After 22 seconds he has lost every rotatory sensation. His threshold for angular impulses appears to be at $2.5^\circ/\text{sec}$. This is the velocity reached at 22 seconds. An illustration of this case is given in Figure 1. Also the normal sensation cupulogram of the same subject is given there.

Two things are striking here. In the first place that the course of the diagram obtained by the subjective estimation of the angular velocity is completely parallel with the sensation cupulogram, and secondly that the absolute value of the subjective estimation at extrapolation towards $t=0$, that means to the moment on which the stimulus is given, balances very well with the real magnitude of the given stimulus. Mostly this a little too high (up to about 50 per cent).

The deviation of the cupula is given by Groen on the basis of mechanical considerations regarding the laws of oscillation (see Figures 3A and 3B).

Approximately

$$x = C \frac{\Theta}{P} \left(e^{-\frac{D}{P}t} - e^{-\frac{P}{\Theta}t} \right)$$

Hence

$$t = \frac{P}{D} \ln \frac{\Theta C}{P x}$$

$$\frac{D}{P} = \frac{1}{10} \text{ sec}^{-1} \text{ approx} \quad \frac{P}{\Theta} = 10 \text{ sec}^{-1} \text{ approx}$$

and

$$\frac{D}{\Theta} = 1 \text{ sec}^{-1}$$

Here C indicates a certain stimulus in $^\circ/\text{sec}$. The deviation of the cupula x causes a certain subjective angular velocity, which is measured. The declining of the subjective angular velocity is the same as the declining of x with t .

The magnitudes of $\frac{P}{\Theta}$ and $\frac{D}{\Theta}$ are found as an average value of a number of normal subjects (van Egmond, Jongkees and Groen*).

We therefore may conclude that the subjective sensation of our subjects is able to give us (though indirectly) some quantitative data on the magnitude of the rotatory stimulus administered to that patient. Figure 2 shows us a number of such cupulograms based on the subjective valuation of the covered angle with the normal sensation cupulogram of

* P = frictional torque at unit angular velocity Θ = moment of inertia D = directive force per unit angle

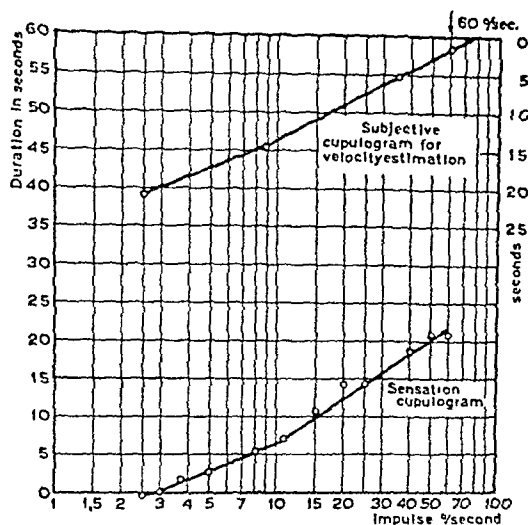


FIG. 1.

A cupulogram taken in the normal way as compared with a cupulogram obtained by the subjective estimation of the covered angle during the after-sensation after the turning test.

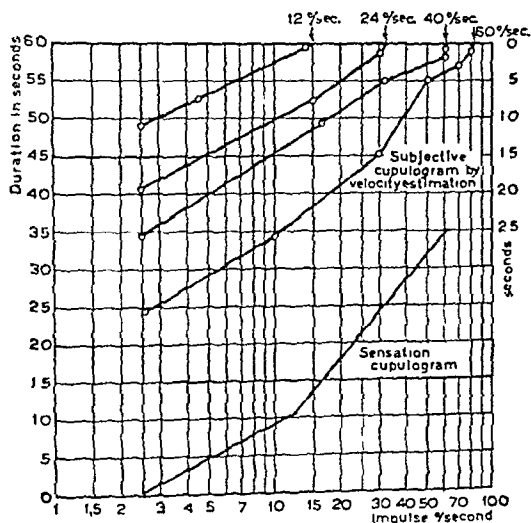


FIG. 2.

In one person the sensation cupulogram (lower curve) and the subjective cupulogram by angular velocity estimation are compared. The stimulus used to take the subjective cupulogram and its strength are indicated by an arrow at the zero point of the diagram.

The Turning Test with Small Regulable Stimuli

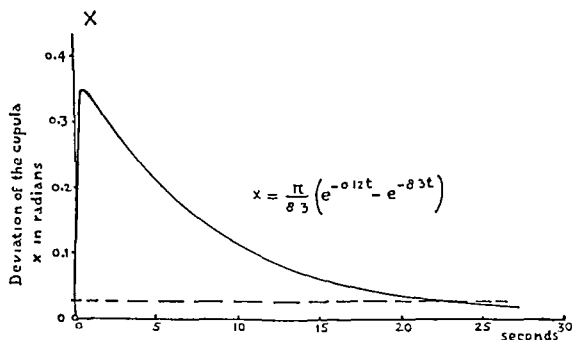


FIG 3A

The deviation of the cupula (ordinate, linear scale) after an impulse of π radians (180°) per second is plotted as a function of time (abscissa). The dotted line indicates the threshold of rotatory sensation. The graph is constructed on the base of a theoretical formula, with the average values found in normal subjects (see text).

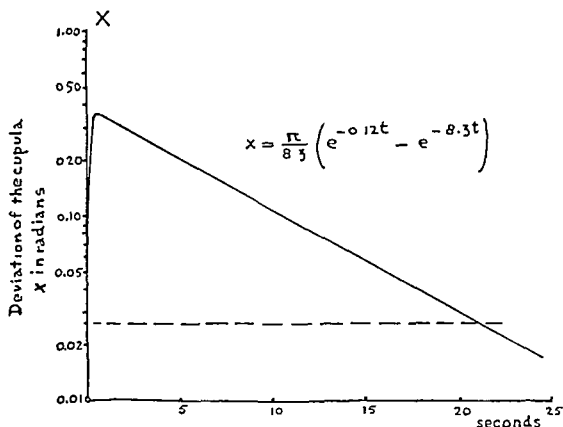


FIG 3B

The same as Fig 3A, but the curve of 3A becomes a straight line, cf. ordinates of the subjective cupulogram (Figs 3A and 3B) it must be kept in mind that they are proportional, i.e. a cupula deflection of $\frac{\pi}{8.3}$ rad causes a

subjective angular velocity of π rad/sec. Thus the factor of proportionality is $\frac{1}{8.3}$

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the same subject underneath. The deviation from the straight line, which we sometimes find in the sensation cupulograms of normal people, return in the same way in this subjective cupulogram and likewise differences in the curves for turning clockwise and anti-clockwise. The quantitative nature at extrapolation (with the above-mentioned restriction) is also very clear.

Summary

By making a subject estimate the subjective angular velocity during the after-sensation after the turning test, it is possible to obtain a fluent cupulogram which not merely resembles even in particularities the normal sensation cupulogram, taken discontinuously, but also appears to determine with satisfactory certainty the magnitude of the stimulating impulse. For clinical use this method is not often serviceable. In those cases in which it is possible to take this diagram, it is an easy and quick check on the sensation cupulogram.

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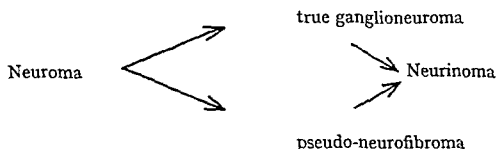
NEURINOMA IN THE NASAL CAVITY

By G. RÉVÉSZ (Budapest)*

NEURINOMA is one of the most infrequent benign tumours of the nasal cavity. In the majority of text-books it is not even mentioned. This is partly due to the fact that, in gross, the tumour exhibits much resemblance to a fibroma which is, in the nasal cavity, a more frequent incidence, wherefore the tumour removed will not be suspected of being a special case. Thus the tumour will not be examined histologically; though the differentiation of fibromas and neurogenous tumours is, regarding the fact that the latter often recur and not infrequently become malignant, rather an important task from a prognostic viewpoint.

To date, only a few reports concerned with benign neurogenous tumours of the nasal mucosa have been published (Mittelbach-Woletz, Cohen, del Greco), while those papers reporting on malignant tumours composed of immature neurogenous elements are rather numerous. As to the neurogenous tumours consisting of mature tissue elements, the origin of the growths and their morphologic evaluation is still an unsettled and much disputed problem.

No doubt the difficulties encountered are partly due to the rather complicated structure of nerve trunks and to the indefinable extraction of their constituents. Tumours may derive from all constituents of a nerve. Those tumours made up of ganglionic cells and nerve fibres, that is the true neuromas, have, by Aschoff, been differentiated from the pseudo-neuromas originating in the connective tissue elements of the nerve. In a true neuroma it is the nerve cell which proliferates, wherefore in these tumours neurofibrilla can be demonstrated. In pseudo-neuromas, growth is due to the connective tissue (epi-, peri- and endoneurium), while the nerve elements proper are few in number. The neurinoma related to both groups constitutes a transition between them.



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Neurinomas being composed of nerve fibres only (without ganglionic cells) contain neither axons nor myelin sheaths (Verocay: *ī*_s, *ī*_{ós}=fibre).

The question of origin and histologic classification is rendered still more difficult by the fact that neurinomas do, regarding the quantity of the constituents and their ratio, display much variety. Herxheimer, further Askanazy, held the view that these tumours derived from the connective tissue. The investigations of Verocay did, however, result in revealing that proliferation starts from the cells of Schwann's sheath. In Erb's more accurate definition the matrix of the tumour tissue is formed by the embryonic predecessors of Schwann's nuclei, that is, Held's neurogliocytes. Thus the tumour starts from ectodermic elements, giving, in the course of their development, rise to the proliferation of the connective tissue elements in the environment (MacCallum). In some cases the proliferation of the connective tissue is rather extensive (fibroneurinoma, neurinofibroma). In Verocay's opinion, also, the neurofibromas are not made up of pure connective tissue elements but of nerve cells or their embryonic equivalents improperly used up in the development of the nervous system.

Growths of similar structure are found in Recklinghausen's neurofibromatosis, also showing that the boundaries between true and pseudo-neuromas cannot be drawn sharply. Acusticus tumours located at the ponto-cerebellar junction belong to the same group and are closely related to those mentioned formerly. The simultaneous occurrence of neurofibroma and neurinoma has been pointed out by Ogilvie. Bing observed multiple neurinomas.

The question whether these growths are true tumours or developmental anomalies is still being disputed. The role of certain somatic evolution processes (puberty, pregnancy, climacterium) cannot be ruled out, especially in the cases of late manifestation. The majority seems, however, to be congenital and slowly growing. There are also data referring to the familiar occurrence of the disease and its heredity, especially in degenerated individuals.

Microscopically, a cellular tissue can be seen, the elements of which are so arranged as to form a curved line (semicircle), a star, or a whirl. As a rule, the cells are elongated, narrow, spindle-shaped. Antoni has described two different histologic types. In the case of type A there are rigid cell bundles arranged close to each other or interwoven or after palisade fashion; the nuclei are like bacilli. Type B is composed of large cells having light staining nuclei arranged irregularly. The arrangement mentioned first is characteristic of neurinomas, whereby diagnosis may be facilitated by its presence. As mentioned, there is a considerable network of parallel reticular fibres filling up the interspaces invariably present. Erb found in neurinomas cavities of various size at the border of which the tissue was rather acellular. He believed that these cavities were due to destruction of Schwann's nuclei lodged rather densely at these places.

The case observed referred to a 52-years-old woman. She reported that her disease had been present for five years. She experienced, during this period, an increasing difficulty in respiration and pains occurring in the right half of her nose. Despite an operation (?) performed the complaints recurred two to three years prior to admission, and became more severe inasmuch as the

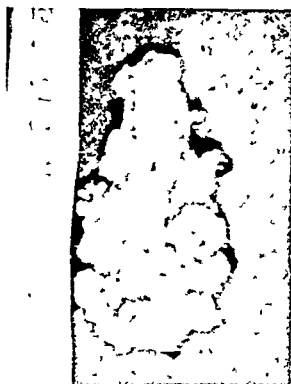


FIG. 1

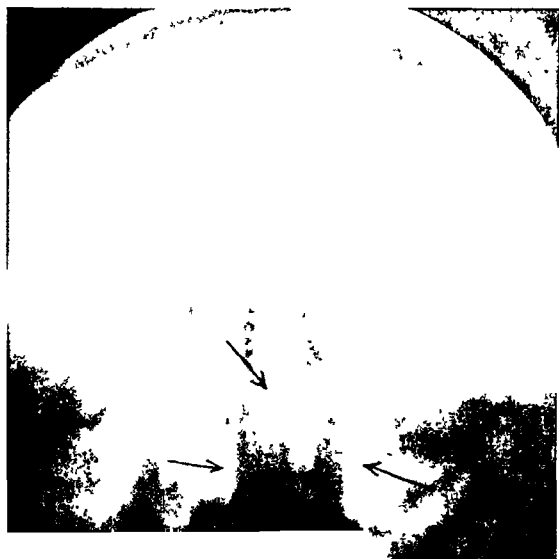


FIG. 2

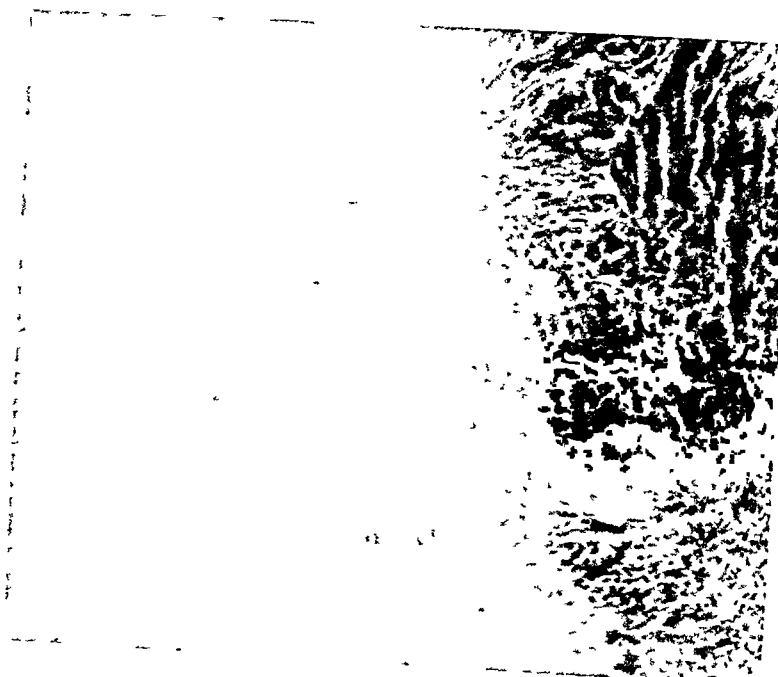


FIG. 3



FIG. 4

Clinical Record

pains extended to the right frontal, facial, and nasal region also. The pain was non-continuous with a sudden onset and relief.

On examination the left half of the nose was broadened, the turbinates seemed atrophic. Inspection into the right meatuses was impossible, on account of a yellow, slightly vascularized, hard mass the surface of which was smooth (Fig. 1). Posterior rhinoscopy showed that the posterior pole of the inferior turbinate was swollen, of uneven surface. There was no pathologic secretion present. The growth was not tender on pressure. On the right side of the dorsum nasi, the skin was paræsthetic. The film showed well-developed paranasal cavities and a rather intensive opacity extending, though sharply limited, to the inferior part of the right nasal cavity and the medial part of the maxillary cavity of the same side (Fig. 2).

Medical, ophthalmologic and laboratory examinations revealed no pathology whatever. The histologic examination of the excised piece showed elongated cells arranged in bundles and whirls, with some rhythmic arrangement of the nuclei. The bundles were œdematous, the nuclei had round rather than pointed ends. This picture was characteristic of a neurinoma (Figs. 3 and 4).

The tumour has been removed by a two-stage operation. In the first stage the visible part of the tumour has been removed in superficial anaesthesia. Ten days later the right Highmore cavity was exposed in superficial and local anaesthesia (Denker's operation) and tissue particles suspicious of belonging to the tumour were removed from it. The wound cavity has, at the oral opening, been closed and a tamponade was introduced through the nostrils while the mucosa of the cavity was being spared. Uneventful healing ensued within one week.

Six months later a follow-up examination took place. No alteration pointing to a neoplasm was seen in the nose. The mucosa was intact, no pathologic excretion was observed. Her smell was normal, she had no pains. The only complaint was a paræsthesia occurring from time to time at the right half of the face.

Thus the case was a typical neurinoma of the nasal cavity from both the clinical and histological point of view. Very likely the complaints preceding the admission by five years were due to the same tumour giving rise to operation. At that time, the tumour had only partially been removed and, owing to the fact that no histology took place, remaining tumour tissue had not been sought for. As to the place where the tumour started, nothing could be ascertained, the site of the tumour does, however, admit the conclusion that it might have originated from a post ganglionic fibre of the sphenopalatine ganglion. The pains were, in our view, partly of reflex origin, whereas they might partly be due to the pressure and distension exerted by the large tumour mass.

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SOCIETIES' PROCEEDINGS

ROYAL SOCIETY OF MEDICINE—SECTION OF LARYNGOLOGY

May 2nd, 1947

President NORMAN PATTERSON, F R C S

Cases

Mr STEPHEN SUGGIT—*Three cases with extensive carcinoma of the hypopharynx*

Mr SUGGIT said that these three cases had their main features in common in that they had extensive carcinoma of the hypopharynx which necessitated a wide excision of the pharynx with complete separation of the œsophagus, which was brought out to a separate stoma in the neck. A three stage plastic skin reconstruction to restore continuity between the pharynx "stump" and œsophageal stoma was necessary, thereby differing from the simpler procedure normally required in a case of lateral pharyngotomy. All three had had gastrostomies done—the first two prior to operation, two or three weeks before the excision of the tumour, in the third he at first omitted gastrostomy, unwisely, and had to have it done within a week or two afterwards. He wished to stress the great advantage of doing gastrostomy before lateral pharyngotomy in all these cases, however small the tumour. The alternative was the feeding tube, and if the feeding tube was left in and changed at intervals there was a considerable amount of regurgitation. Even without the feeding tubes there was regurgitation, and it was important to keep the area covered with buffer gel, pH 8. The alternative to the feeding tube permanently in place was a tube put in at every feed, and he thought this caused trauma and was better avoided.

The first two cases were cases which had been sent to the deep X-ray department by outside surgeons, but had been referred to him by Dr Gwen Hilton who considered that the possibilities of radiation were not at all promising, and that if surgery could be done it was worth attempting. In the third case the question of radiation was not discussed. The first case had the growth excised just a year previously, while the last case was only very recent, 3 months, and was included to show an intermediate step in the plastic closure.

Mr Suggit then proceeded to show a number of slides illustrating the appearance before and during operation and the stages of reconstruction. One of the slides was an X ray film of the reconstructed junction.

In the second case, that of a man in showing the condition of the neck after operation, Mr Suggit said that the hair created another problem in reconstruction. He was given an epilation dose of X rays. In removing some of the dead hair he noticed a minute nodule in the muco-cutaneous margin of the

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pharyngeal stoma and in the zone of the epilation irradiation, which was nipped off. Professor Cameron said that it had the appearance of squamous carcinoma cells which were no longer viable. To be on the safe side he was given contact X-rays to the pharyngeal stoma, 3,000 r, and he was in hospital for nearly six months instead of the more usual four.

He called attention to the manner in which the acromio-thoracic pedicle was used to fill the defect in the neck after the pharyngo-oesophageal skin tube had been formed from a large ellipse of skin enclosing the two stomata of the pharynx and oesophagus. Microphotographs of the three tumours were shown.

Mr. Suggit's remarks were followed by a short film-strip which had been made by Dr. Russell Reynolds and illustrated the swallowing action after reconstruction. Eighteen days after reconstruction of the oesophagus in the second case, a man aged 71, the swallow, as illustrated by the barium meal, exhibited a certain degree of hesitation and hold-up. The next strip showed the same patient 32 days after reconstruction, when the swallowing was very much better and easier. Another strip showed the first of the three patients, a woman aged 62, and was made five months after the reconstruction of the oesophagus.

CASE HISTORIES

CASE I. *Woman aged 62.*

Two and a half years increasing difficulty in swallowing.

Two stones loss of weight in two years.

Carcinoma posterior pharyngeal wall.

18.4.46. Gastrostomy by Mr. Harris.

10.5.46. *Left lateral pharyngotomy.*

Intramuscular penicillin begun 24 hours pre-operatively. Several large glands at bifurcation of left carotid clear on section. Adherent to RIGHT lateral lobe of thyroid, part of which was removed with the tumour but found to be outside the zone of infiltration on section.

Histology. Squamous carcinoma, Broder Grade 1.

29.5.46. Acromio-thoracic tube pedicle graft made.

19.6.46. Acromial end of graft transferred to lateral side of upper stoma.

27.6.46. Tracheotomy tube discarded.

10.7.46. Reconstruction of junction between pharynx and oesophagus under general anaesthesia, using No. 9 Jacques catheter, pedicle unrolled and used to fill the defect.

20.7.46. Jacques catheter removed.

24.7.46. Began swallowing.

21.8.46. Discharged home: gastrostomy retained but not used after end of August. Discarded 19.9.46.

12.12.46. Film of barium swallow made.

20.3.47. Gain in weight since last May, 2 stones.

CASE II—*Man aged 71.*

Three months increasing difficulty and pain on swallowing.

Carcinoma hypopharynx left anterior wall.

5.9.46. Gastrostomy by Mr. Matthews.

20.9.46. *Left lateral pharyngotomy.*

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Intramuscular penicillin begun 24 hours pre operatively One gland at bifurcation of left common carotid artery clear on section

Histology Squamous carcinoma, Grade 1

3 10 46 Tracheotomy tube discarded

9 10 46 Acromio thoracic pedicle by Mr Matthews

8 11 46 12 11 46 Epilation dose of radiotherapy to pharyngeal stoma
750 r

20 11 46 Tiny nodule at upper posterior angle of pharyngeal stoma noted and removed by punch forceps *Histology* 'Numerous squamous carcinoma cells so distorted by the effects of radiation that they cannot be considered viable' Professor Cameron

11 12 46, 15 12 46, 17 12 46 Contact radiotherapy to pharyngeal stoma
3 000 r

10 1 47 *Reconstruction of junction between pharynx and œsophagus*, under local anaesthesia

21 1 47 Began swallowing

28 1 47 First ciné film of barium swallow made

31 1 47 Pedicle trimmed

13 2 47 Second cine film of barium swallow made swallowing appears perfect

24 2 47 Gastrostomy tube discarded

CASE III—Woman aged 46

Three months difficulty in swallowing, greater for solids than liquids

Carcinoma posterior pharyngeal wall

24 1 47 Clearance of teeth under general anaesthesia and biopsy

Squamous carcinoma, Grade 1 (Broder)

7 2 47 *Left lateral pharyngotomy*

Continuous drip pentothal (Dr Beaver)

Intramuscular penicillin 24 hours pre operatively

One large gland on the jugular vein and one large gland at the bifurcation of the left common carotid artery clear on histological section Tip of superior pole of lateral lobe of thyroid gland, which was lightly adherent to the growth was clear on section

14 2 47 Tracheotomy tube discarded

21 2 47 Gastrostomy by Mr Hickey

4 3 47 Acromio thoracic tube pedicle made

14 4 47 *Reconstruction of junction between pharynx and œsophagus*, under local anaesthetic

2 5 47 Gain in weight since operation 9 lb

Mr E D D DAVIS congratulated Mr Suggit on the results of these cases they were good There was one question he desired to ask What was the advantage of the pedicle flap over the flap at the time of operation? The advantage of the latter was that the skin and mucosa edges could be stitched and the wound made smaller, and he would like to know whether the pedicle flap was an advance on that He quite agreed with what Mr Suggit had said about gastrostomy—he thought it an advantage The patients were not comfortable with the tube, they were very anxious to get rid of it

Societies' Proceedings

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Investigations X ray, chest normal W R negative Blood count Hb 102%, W B C 5,200 (polys 56%, lymphos 40%) Throat swab No organisms in smear *Str viridans* and *M catarrhalis* on culture

Patient is under the care of Mr Frederick Roques, who reports that there is a red inflamed area on inner aspect of labia

Treatment Denture discarded for two weeks Vitamin B complex (1 mg B₁, 1 mg B₂, 15 mg nicotinic acid) has been given twice daily for same time

25 4 47 Ulceration appears less active, but no change in distribution

Mr MONKHOUSE said that in Behcet's disease the mouth, vulva and eyes were all affected In this case the eyes were normal, but there was a vulval lesion about which he regretted that he had not had time to obtain an opinion

Pemphigus had been suggested, but the fact that the skin was not involved, although the disease had been present in the mouth for four years, was against this diagnosis

Mr MOLLISON considered that this was one of the cases of recurring ulcers in the mouth the pathology of which was very vague He had seen recently two similar cases in one of them the ulcers recurred in patches over a large number of years, and the patient, whom he had known for twenty years, casually mentioned the fact that he had repeated ulcers, they were completely cured for a few days with penicillin, but recurred in a short time In another case a woman was suffering from ulcers involving the tonsil and it was rather thought that the focus of infection there might be worth removing The tonsils were removed and there was a slight improvement, but she had not lost all her ulcers

Mr R G MACBETH said that this case reminded him of an almost precisely similar patient reported recently by the Gynaecological Department at Oxford In the latter case it had been found that the blood ascorbic acid level was nil, and that large doses of this drug had effected a cure

In another obscure case of pharyngeal ulceration in a soldier, the patient's plasma level for ascorbic acid had been found to be extremely low and although no Vincent's organisms had been recovered from the ulcers, the condition had been improved by giving ascorbic acid and painting the local condition with N A B in glycerine

Chronic laryngitis for diagnosis—WILLIAM MCKENZIE

Mr G, aged 53 First seen *January 1st, 1947*

History Hoarse for eight years Report (from New York) Direct laryngoscopy three times between *April, 1945*, and *March, 1946* Biopsy showed no sign of malignancy Diathermy attempted on second occasion but abandoned owing to patient's general condition

April, 1945 Chest X-ray negative Sputum negative for T B one year ago

On examination Marked generalized congestion of larynx, thickening of both ventricular bands and arytenoids, more marked on left Both cords move well Appearance of larynx has varied, when first seen in *January* the thickening was confined to the ventricular bands

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W.R. negative according to patient.

Treatment has been symptomatic.

Mr. McKENZIE said that this patient had been already investigated very fully in America, and he thought from his description he had better be left alone for a short time and just watched. The only thing in his history was that he had drunk a good deal in his time. The striking thing about his larynx was that the appearance changed. He never saw him twice the same. When the patient came to him his first question was, "What is wrong with me?"—which he could not answer—and his second question, "Shall I need a tracheotomy?" and he thought it was fair on the history to say that probably he would not need a tracheotomy. To-day the actual area of oedema was greater than it was since he had seen him.

Mr. McKenzie added that the Wassermann test was negative. X-ray of the chest revealed slight bronchitic changes but was otherwise normal.

ROYAL SOCIETY OF MEDICINE—SECTION OF OTOTOLOGY

SPECIAL MEETING

September 12th, 1947

President MR H V FORSTER M C in the Chair

The paper was followed by the projection of the film "To Hear Again"

Rehabilitation of the Deafened

By NORTON CANTFIELD M D * (Yale)

A combination of old and new techniques [1, 5, 7 10 11 12, 14, 15, 19] under the guidance of someone who has a broad view of the entire field of human hearing, has emerged since the recent war to help every individual handicapped by abnormal hearing. No longer need the doctors say that nothing can be done—no longer are those so handicapped, doomed to a life of distorted sound. Discouraged and disheartened though they may be when they seek help, this serious psychological situation is no longer hopeless, because most of these patients can enjoy the benefits of communication with their fellow man by means of sound. Thanks to the development of the telephone, radio, television and the recent progress in the electronic industry, science now can have complete control of sound and can use it for the benefit of those whose handicap was once an almost unbearable burden.

This discussion will not be concerned with those unfortunate few whose serviceable hearing was absent at birth or who lost it in the first five years of life. I shall confine my attention and remarks to those who once heard, *but* whose hearing function has been partially or largely lost by some acquired defect after they have learned to speak. They are frequently spoken of as the "hard of hearing" or the "partially deaf". A non-euphonious term, "baryecoa", is found in medical and general dictionaries for the condition from which these people suffer, but this word is seldom used.

The 10 per cent of our population who have an appreciable hearing loss can benefit by the professional attention of the modern audiologist. Three or 4 per cent need the complete rehabilitation programme.

Medicine has shared in the recent advancement enjoyed by all branches of science. For many years in the minds of a few civilian otologists there existed the ideas necessary to put into operation a complete programme for the deafened. Notable among these was the late Dr Walter Hughson of Abington, Pennsylvania, a pioneer in audiological research.

* From the Division of Otolaryngology Department of Surgery Yale University School of Medicine New Haven Connecticut

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The medical profession has struggled with the problem but neither medical schools, foundations for research nor community projects have supplied the facilities to establish centres for the rehabilitation of the deafened. When the U.S. Army authorities realized that a large number of its men were so handicapped as to require specialized training and assistance, extensive programmes were established between the years 1943 and 1947 in both the Army and the Navy [18, 21, 22]. Approximately 14,000 service personnel have been given the benefit of a programme which will be portrayed in the film which follows these remarks. The project was so effective that both the Army and the Navy are continuing during the peace-time years and the Veterans Administration has a programme just as extensive for those who *were* released from service without the attention which was their due.

So intimately related to hearing are all phases of human speech that in each centre now established, speech analysis, speech reading and speech correction are all considered and appropriate training advised and provided.

Psychologic situations are so important that each patient is carefully evaluated from this angle [3, 4, 9, 13, 17]. To our surprise in the Army units, complete psychogenic deafness was not rare nor was it found solely in the combat troops. In one hospital where 76 cases of psychogenic deafness were proved by the narcosynthesis method, 43 or 55 per cent. had reported a history of defective hearing before entering the Army, 25 of whom had had noticeable deafness for more than ten years. Only 12 or 16 per cent. of this group developed their hearing loss in overseas combat. It is now considered that if any medical treatment is followed by a hearing improvement of more than 40 decibels in the speech frequencies, there is a strong possibility that some or all of the improvement is on a psychogenic basis.

To determine if a hearing loss is psychogenic is not a simple matter. Usually a series of tests (some of which will be depicted in the film) are necessary. Observation by several members of the staff will result in inconsistent or incompatible findings which lead to the suspicion of the nature of the loss. Final proof is obtained only after a marked audiometric improvement of 30-60 decibels without obvious organic reason. The role of the psychiatrist is paramount and such hysterical cases should be under his care.

One of the tests used at the Deshon General Hospital during the War, in the Rehabilitation Service under the direction of Dr. Edward H. Truex (Junior), [6, 8, 16], was known as the Doerfler-Stewart test [2], and is based on the fact that the human ear can understand speech when the background noise is at a certain level of intensity. It was discovered that a person with a pure organic loss could still understand speech when the background noise was 10-15 decibels louder than the speech. In cases of psychogenic deafness, however, the background noise would render speech unintelligible when the noise was at a level considerably lower than the speech itself.

I would like to present briefly, four case reports of the group which was treated at the Deshon General Hospital. Again we are indebted to Dr. Truex for these reports, the actual psychiatric work having been done by Dr. Peter Knapp, now of the Psychiatric Staff of Harvard University Medical School.

CASE I.—This patient was a 27 year old captain in the infantry who was admitted to Deshon in October, 1945, because of severe hearing loss which

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resulted from a shell burst in September, 1944. The shell struck a wall about four feet above his head rendering him unconscious for a short interval, and upon recovery he noticed moderate hearing loss. Since then the hearing had become progressively worse.

He bought a hearing aid in February, 1945, on recommendation of physicians. The aid helped him considerably, but the loss of hearing continued to increase.

Superficially the past history was non-contributory. He had had otitis media in the left ear when he was a child and minor wounds prior to the above incident. The physical examination revealed nothing of particular consequence. Both drums were thickened, scarred and fixed.

The initial hearing tests showed an inordinately large loss for A C and B C in both ears, and loss for speech was correspondingly large.

By the D-S test a threshold of 80 decibels was found, but noise at 80 decibels masked speech at 85 decibels. In view of these findings along with observations reporting the patient as being a "rigid perfectionist who is tense, restless and apprehensive", a tentative diagnosis of deafness with functional overlay was made.

For three months psychotherapy was carried on before satisfactory results were obtained. This therapy included about sixty hours of individual interview, eight of which were conducted while the patient was under intravenous barbiturate narcosis.

As his life history unfolded the genesis of his existing malady revealed itself. It all revolved around a complete rejection of the boy by his parents who were highly neurotic and selfish. One of his first terrible memories which was revealed under narcosis was that of being sent off to boarding school all by himself on a transcontinental train when he was seven years old. His father was a "compulsive driving salesman", and the patient hated him. The father's lashing tongue and iron hand were deeply imprinted on his memories, and he loathed his mother who did not protect him. He was rebellious as a result, defying his parents, swearing at his mother, running away, and fighting. He was enuretic nightly until his mid-teens for which his father "chastised him, spanked him, cursed him" and on occasions rubbed his nose in the urine. He organized his life around the prevention of the detection of his enuresis.

A large part of his neurosis arose in the sexual sphere. This phase of his life suffered seriously and became deeply inhibited through the physical and mental tortures administered by his father in dealing with such matters. His frustrations continued into his married life which had its beginning just prior to going overseas and was completely unsatisfactory sexually.

His aggressiveness was partially satisfied in combat as a Ranger. He was a good leader, efficient and valorous and was decorated accordingly, but his combat activities were primitive and violent. He had shown signs of breaking about six months prior to the final traumatic experience, and on one occasion he was hospitalized for three days because of neurotic symptoms. The final traumatic incident related in the admission history took place in a mountain pass which he was supposed to hold with his unit for forty eight hours, but instead he remained there for thirty days under constant attack. His memory thereafter was vague, a partial amnesia having developed. He

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continued duty after a brief period of recuperation, though the medical records indicated "a struggle between his will to carry on and increasing tension".

During the prolonged period of therapy at Deshon it was evident that he was gaining insight into his own personality, but it was not until late January, three months after admission that symptomatic improvement began. I am using the words of the psychiatrist who directed therapy in describing the most dramatic episode.

"That evening, under amytal, he groped fitfully through his early memories, saying virtually nothing for almost an hour. Again he returned to the pass in Italy. . . . The therapist asked 'What did you think in the pass?' He half *abreacted* as he spoke of the strain of the long vigil there. Then he uttered the words, 'I didn't want to see any more war; I didn't want to hear any more war.' At once he stiffened out, sat up, asked to be spoken to—and took his hearing aid out to stay."

The following day his hearing was normal. Therapy was continued for two additional weeks in an effort to completely resolve his neurosis and establish a genuine understanding of his condition. Results were satisfactory, but the depth of his turmoil forebodes a very stormy future.

CASE II.—The next case is that of a 24 year old private first class whose defective hearing resulted from the premature blast of a booby trap that he was setting up at Fort McClelland, Alabama. The blast stunned him and caused bleeding from both ears. He was hospitalized for a brief interval and returned to duty with diagnosis of nerve deafness. The hearing became worse and eight months later he was hospitalized again and was found to have about 80 decibels loss of hearing in each ear. Additional symptoms consisted of constant tinnitus, occasional spells of transient dizziness, frequent left frontal and temporal headaches and nervousness about his hearing loss.

During the processing period at Deshon several factors came to light which suggested functional hearing loss in spite of a perforation in his left ear drum with slight drainage from the middle ear. He told the examining otologist that his hearing seemed to be considerably worse when he was nervous. The first series of hearing tests gave added weight to an initial impression that there was some functional element.

The pure tone audiogram revealed 79 and 70 decibels loss in the right and left ears respectively, with a corresponding depression of bone conduction. This we now believe to be an inordinately large degree of loss. His loss for speech was recorded as 61 decibels which is not inconsistent with the pure tone loss. Four days later, however, loss for speech was recorded as 46 decibels, whereas that for pure tones was relatively constant at 76 decibels and 62 decibels in the right and left ears. The D-S test supported the tentative diagnosis when a threshold for speech was found at 40 decibels, and 46 decibels of noise *masked* speech at 45 decibels.

A few significant facts were elicited by the neuro-psychiatrist during his preliminary study. The patient's mother and father were aged and chronically ill, and the former was highly excitable and nervous. Illness had prevailed in the family throughout his life though he himself had always been well. It was evident, however, that his civilian life was fraught with excessive worry over finances, farm management and family quarrels, and that a state of chronic

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tension and anxiety existed. Under intravenous pentothal he abreacted cleanly giving full vent to his suppressed emotion. In the words of the psychiatrist, the patient described the "intense anxiety he had, on going into the service, his feeling that he had been wronged by the Draft Board, the amount of money he had lost by selling all his stock . . . his agitation after the blast injury at finding himself hard of hearing. . . . He wept profusely at the thought of neglect accorded him by physicians and at reflection on the hardships endured by his wife." As he emerged from the drug, suggestion therapy was begun and upon regaining full consciousness his hearing was essentially normal. Even the tinnitus had disappeared.

CASE III.—A 25 year old technical sergeant was admitted to the hospital in November, 1945, with an excellent military record. His history was not unusual. He had had several earaches in childhood, but no further aural trouble until October, 1944, on Leyte, P.I. He was exposed to considerable mortar and artillery fire which caused tinnitus and mild impaired hearing bilaterally. The impairment persisted and in May of 1945 on Mindanao a mortar shell blasted nearby causing a back wound, bleeding from both ears and deafness. The hearing acuity improved somewhat the next day, but there had been no change since that time until he was hospitalized. The remainder of the history was non-contributory, and inspection of the ears revealed no abnormality.

He was tense, restless and moody. His first series of hearing tests showed an average of 59 and 52 decibels loss in the pure tone speech range in the right and left ears respectively. Loss for speech, however, was recorded as 30 decibels.

This discrepancy along with a mildly suggestive D-S test and his evident tension raised the suspicion of functional loss. A second test five days later gave added weight to the tentative diagnosis. Loss for speech was recorded as 35 decibels, yet pure tone loss was now 87 and 85 decibels.

During the course of the psychological interview it was found that his background was superficially normal, that both parents were highly strung, tense and extremely strict, and that he had frequently experienced "uncontrollable sensations of rage".

Since his injury which terminated eighteen months of combat in the Philippines, he had been "restless, irritable, depressed" and bothered by nightmares along with a feeling of isolation and discouragement.

Treatment was begun, and under pentothal he related his hates, his fears and angers and even relived many of his experiences.

He wanted to forget war. He wanted to forget his best friend who died in his arms after being ripped to pieces by machine-gun fire, his second lieutenant whom he found pinioned to the ground by a stake driven through his stomach and his nails pulled out. He wanted to forget the nine men out of the fourteen in his command who were killed by three tricky Japs whom they were taking prisoner. He wanted to forget the many Japs with hands raised in surrender that he mowed down mercilessly after the above incident and the heads he cut off to place beside his foxhole. He wanted to forget the three Japs he had killed and gored with a bulldozer, their heads and their gold teeth that he had saved. For an hour he related these horrors which he had been experiencing for

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many months. The emotional relief was amazing and was followed by suggestive therapy along with faradic stimulation over the mastoids. The following day his hearing was normal.

One more pentothal interview was necessary following a bar-room brawl during which he pulled out a knife and began trembling with fear that he would kill again. Under narcosynthesis he again released pent-up aggressive emotion and thereafter began to gain the insight needed for a reasonably good cure.

CASE IV.—This patient was a 34 year old coloured private first class who had had two years of military service in the United States prior to admission to the hospital in July, 1945, because of deafness. In November, 1943, he had noticed the onset of tinnitus and mild hearing impairment following exposure to machine-gun fire on a firing range. He became concerned about his ears, which thereafter got progressively worse. Headaches and symptoms of gastric dysfunction associated with nervous tension became apparent in July of 1945, and hospitalization resulted.

The following history was elicited by the psychiatrist.

"The patient was extremely nervous as a child, enuretic until the age of 12, subject to fears. . . ." His father was a "brutal alcoholic who kept the home in turmoil." He was in constant "conflict with his father as he grew older". He was restless and rebellious throughout his formative years which were further marred by a feeling of racial persecution. Conflicting with these untoward conditions was an ambition to amount to something. He avidly pursued a course of study at night school and acquired "the equivalent of one year of college education". Economic necessity forced him to quit however, and he had to content himself with menial jobs. "At the age of 20, the stresses and strains of his life provoked a 'nervous breakdown' lasting four months, requiring constant medical care. The patient was depressed and at this point contemplated suicide." He recovered satisfactorily, however, and settled down to work but remained "tense and lonely".

Immediately upon entry into the hospital it was evident that he was a psychiatric problem as well as an audiologic. He had a complete loss of hearing by audiometric examination and 88 decibels loss by speech reception testing. The discrepancy along with the apparent severity of the deficiency indicated functional hearing loss. It was the opinion of the medical officers that there was no organic damage.

Psychotherapy was begun and carried out intensively over a period of four months. Several interviews while the patient was under narcosynthesis did not yield the dramatic results portrayed in the preceding cases. Yet gradual improvement resulted until the hearing reached a stable level at about 60 decibels.

It is still possible that this man's remaining hearing loss is psychogenic and that further improvement could not be effected because of the severity and depth of his personality disruption. He was finally discharged with a hearing aid which reduced his threshold for speech from 50 decibels to 9 decibels. He was considered symptomatically improved.

[Two illustrations of each case were shown at the Meeting.]

As was expected following the war, the intense interest in hearing and what could be done for those afflicted with a loss of serviceable hearing, has been

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the basis for establishing at least fifteen university programmes to improve on what is already an exceptionally good project.

Why is this method superior to our pre-war attention to these patients? The answer lies in the fact that the return to the patient's normal socio-economic life demands a concentration of the professional ability of six to eight different specialists. The otologist, the psychiatrist, the psychologist, the acoustic physicist, the auditory trainer, the lip-reading instructor, the social service worker and the occupational guide, must all work as a single staff, co-ordinating their efforts and constantly exchanging ideas for the benefit of the patient. Any programme which offers less than this will provide many patients with incomplete and inadequate service and will hence fail to meet their professional needs.

Such well-organized groups can handle a continual patient load of between one and two hundred or a balanced staff can rehabilitate from 1-2,000 patients a year, offering a complete course in a period from 4-6 weeks, 4-5 hours per day [20]. To best illustrate these remarks I will now present the film "To Hear Again", which is considered to contain the main ideas on which to establish more of such centres. Details of technique will be varied by the different workers in the field and progress in all phases is inevitable. Since the psychiatric technique with these patients is only in its embryonic stage at present, you may not agree with the methods used. The film does, however, provide a historical record of what was done and as such will stand as a milestone on the road of audiologic progress. To the authorities of the U.S. Army, we are indebted for the production of the film. To the visionary and progressive audiologists who did the work in our service centres we are indebted for the scientific progress already made.

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DISCUSSION

Mr. MYLES FORMBY said that it gave him great personal pleasure to welcome Dr. Canfield back amongst them. It was his good fortune to be associated very closely with him for three years during the war, and on more than one occasion during that time he was deeply envious of what he was able to do and of the really magnificent set-up which he had in his otological service. He was sure that those who had witnessed the film that afternoon and had heard his presentation would agree that here again he had secured a great triumph and had shown them something of which they must be extremely envious.

In this country the system of dealing with people invalided from the Services was very different from that which obtained in the United States. Rightly or wrongly, in this country, when a soldier had finished his service and was assessed by a medical board as having a disability, he was handed over to the Ministry of Pensions to be dealt with, and here there was nothing comparable to the rehabilitation organization or the Veterans' Association such as Dr. Canfield had told them about.

On the psychological side of these cases, he was very much interested to hear of the high proportion of cases of deaf persons invalided from the American Army whom it had been possible to treat and to rehabilitate.

Air Commodore E. D. D. DICKSON said that he, too, wished to express his pleasure at meeting Dr. Canfield again. The R.A.F. had tried to emulate the American pattern in a very modest kind of way.

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Deafened service personnel who are in need of rehabilitation fall into one of the three following categories

(1) Those whose deafness is directly attributable to service causes and is the result of an occupational hazard By this I mean deafness resulting from gunfire, high explosive, flying, exposure to excessive noise, to disease endemic to a particular theatre of service, or arising directly from service conditions

(2) Those who had some hearing defect at the time of entry into the service, which was not causing an obvious disability and which has either progressively become worse irrespective of service conditions or has been aggravated as a result of service conditions or hazards An example of this type of case is one with slight unrecognized middle ear deafness, progressively getting worse as a result of exposure to noise or repeated maladjustments to barometric pressure variations

(3) Those who have some gross hearing loss and damage to their ears (C S O M, otosclerosis, nerve deafness) prior to joining the service whose defect was undetected and consequently unrecorded in official documents

For the purpose of pension or rehabilitation at public expense the disability must be attributable to or aggravated by service If the disability is not recorded in the medical report made by the National Service Medical Board at the commencement of service it is assumed in the absence of definite evidence to the contrary not to have been present at the time If the patient denies its presence on entry the disability is conceded as being attributable to Service causes At this point I wish to stress that so long as the examination of ears and the testing of auditory acuity are carried out in the perfunctory and most unsatisfactory method at present prevailing cases falling into Class '2' and "3" will for ever present a serious problem by assessing the degree of aggravation or deterioration and the eligibility to be rehabilitated at public expense

One has only to peruse documents of recruits to find only too often that the only information available in the space reserved for ears and hearing is a mere tick!

I wish to stress these points very strongly in the hope that National Service Medical Boards will pay closer attention to this part of a recruit's anatomy

At no time is one faced with a bigger puzzle than when one is asked to assess the percentage of disability when a patient is boarded or released from the service, in the absence of an accurate record on entry

Usually, the patient is given the benefit of the doubt but there are many who help to swell the pay roll of Pensioners whose disability was present on entry and has in no way been aggravated by service conditions

I have been struck by the small number of cases of marked deafness in the R A F attributable to service and which give rise to a disability necessitating rehabilitation This is probably accounted for by the nature of their duties which does not expose personnel to the same degree of gun fire or shelling as experienced by the Army or Navy

The vast majority recommended for rehabilitation have had a pre existing hearing loss aggravated by service or have a hearing defect which has progressively got worse

In this country it is the responsibility of the Ministry of Pensions to institute the rehabilitation of deafened service personnel of all ranks, whose disability

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is attributable to or aggravated by service. By rehabilitation I mean a course of lip reading and/or the provision of a hearing aid. There is no organized scheme or set up available for the systematic rehabilitation of service deaf. After their discharge from the service and their return to their homes the co-ordination and supervision of different forms of treatment become impracticable.

This is an example of the procedure laid down by the Ministry of Pensions, for Army personnel from which I quote :

"The patient will be examined by the Service Otologist and if the latter recommends an aid for hearing and it is obvious that the deafness will be accepted as attributable to service, the patient will be referred to the Chief Regional Officer of the nearest Regional Office. An instrument based on the Otologist's recommendation will be selected from types scheduled by the Ministry and arrangements made for it to be loaned to the patient by the maker for a period of one or two weeks in order that its suitability may be decided. At the end of the trial period the patient will be again examined by the Service Otologist. If the Otologist recommends the provision of the apparatus and/or instruction in lip-reading, that recommendation will be referred to the War Office for approval before transmission to the Chief Regional Officer. When there may be reasons to doubt whether the deafness can be accepted as attributable to military service, the patient will only be referred to the C.R.O. after the War Office have approved the Otologist's report. Instruction in lip-reading will normally be provided by a lip-reading class or by individual tuition under the auspices of the Local Education Authority. The course of instruction sanctioned will be limited to that which will enable the patient to obtain proficiency by subsequent practice and in the first instance will not exceed twenty lessons at the rate of one a week or twenty-four lessons at the rate of two a week. (Does not state whether tuition is to be individual or collective.) Replacements of batteries and repairs, maintenance and adjustment of aids to hearing will be effected on application through the C.R.O. for so long as the individual continues to serve in the Army."

To obviate all this time lag the R.A.F. has undertaken the rehabilitation of its deafened personnel prior to release or invaliding. All cases (airmen and officers) attributable to or aggravated by service are referred to the Consultant for assessment. He is the only authority who decides on the suitability of the case, the course of rehabilitation to be adopted or the supply of a hearing aid. Having obtained authority from Air Ministry, a matter of a few days, he institutes treatment forthwith.

A course of twelve personal lip-reading lessons of forty-five minutes duration three times a week is given. When a hearing aid is considered necessary it is supplied on trial and test during this period. The patient is under the supervision of the staff of the Department of Otorhinolaryngology during the whole of his rehabilitation. Apart from the Consultant Otologist, it includes a W.A.A.F. officer trained in Psychology, a lip-reading teacher, and laboratory facilities with technicians for testing equipment and aids. The purchase of the aid is only sanctioned after we are satisfied that it meets the patient's requirements. If the patient leaves the service he keeps in touch with us and is advised to join a hard of hearing club or lip-reading classes nearest to his home.

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The maintenance of the aid and supply of batteries so long as the patient remains in the Service is the responsibility of the R A F. On release or discharge, the responsibility falls on the Ministry of Pensions. The R A F has gone a step further and rehabilitates cases which are *not* attributable to or aggravated by service. The maintenance however, of any aid supplied is the responsibility of the patient. The only cases whose rehabilitation by the Service is inadmissible are officer patients whose disability is not attributable to or aggravated by service. These are given all the help and advice but must defray the expense of their rehabilitation.

These arrangements enable the patient to embark on a career in civil life with as little waste of time as possible to himself. The results so far obtained give us cause for encouragement to continue with the present arrangements so long as facilities and staff permit it.

Mr SCOTT STEVENSON said he was very glad to hear from Air Commodore Dickson of what the R A F was doing for its deafened personnel. In the other Services deafened ex-service men and women came under the Ministry of Pensions and he strongly objected to the old fashioned attitude they had, this was not the fault of their otologists but of the administrators. The Ministry of Pensions' idea of rehabilitation was to fit the man with a hearing aid, trying out a few aids on him until they found what he thought to be the right one and then the man was sent to one of the commercial firms and obtained the hearing-aid. The maintenance of the aid was entirely in the hands of the makers. Other men were sent to lip reading classes, such as those conducted by the National Institute for the Deaf, but the one was not looked upon as the complement of the other, only as a substitute. Under the Deaf Persons Act, 1944, all deaf persons were entitled to training and rehabilitation, but nothing whatever was done in the way of special provision for the deaf, and he personally knew of a case in which training had been refused to a man because of the difficulties of communication arising from his deafness. The Ministry of Pensions might talk about rehabilitation, but it just did not take place at all in the true sense of the word, so far as the deaf were concerned. Statistics had been asked for after the first world war there were 33 000 persons from the services who were granted pensions on account of hearing loss. The number of similar persons in the recent war, according to a Government spokesman recently in the House of Lords, was just under 5,000. He did not know why the figure should be so much smaller for the second world war, whether it was that the prolonged trench warfare restarted old ear trouble, or whether earlier notice was taken of ear disabilities in the recent war. But it should be noted that only cases "attributable" to war service received hearing aids, cases "aggravated" did not, and that was a wrong attitude. He felt strongly that wider responsibility should be assumed for the deafened ex serviceman, and, indeed, for the deafened man in industry. This was not being done at present, and he hoped that their otologists would stimulate the Ministry of Pensions to move more actively in the matter.

Mr I SIMSON HALL said that the provision of such services as Dr Canfield had outlined to them was a question of real importance. As they all knew, we were short of everything in this country, except austerity, and among other things we were short of lip reading teachers and people who were competent

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to deal with such cases as these. He hoped that this defect would be remedied in the future.

He asked whether Dr. Canfield could give them some idea of the personnel required to run the centre of which he had spoken. What was the number of trained personnel required in relation to the output of such a clinic as they had seen in operation on the film.

Mr. L. GRAHAM BROWN asked what was done to separate the true psychogenic cases from the malingerer. Was that an easy matter or was it not? Did malingering border on the psychogenic case? Were there not a large number of doubtful cases in which it was impossible to say whether the case was a truly psychogenic one or whether it was a case of malingering?

Dr. CANFIELD first replied to the question as to the number of personnel at the clinic which was shown in the film. There was a Chief Director of Medical Services and under him were acoustic technicians, a supervisor of speech and hearing production, a clinical psychologist, and an educational and vocational expert. There were also psychometrists, auditory training instructors and speech correctionists. The medical staff numbered about 30 per cent. of the total professional staff. A staff of twenty to thirty people could handle 100 patients at one time. The programme for each patient required five hours a day for 4 to 6 weeks, but it was varied according to individual needs and the amount of instruction which the patient had received before he went to the clinic. He did not wish to over-emphasize the psychiatric side of the work; it was really only a small part of the whole, even though it might have seemed to have been emphasized in the film. But in the course of the work, cases arose which baffled them as otologists and it was a natural result to go to the psychiatrist. The programmes had been designed with a view to doing complete psychological analysis in all cases. It was necessary therefore to have available the services of well-trained psychiatrists.

He could understand very well some of the problems which Col. Drummond had put forward, and he was sure that he was well aware of the psychogenic situation.

Mr. Simson Hall had asked how he obtained staff for this type of work. He agreed that this was extremely difficult. The three units concerned were being turned into training places for personnel. He was very glad Mr. Ewart Martin had testified to the accuracy of the film. The dramatic side of it was quite as pronounced as the film. He added that the film was available through the Military Attaché of the American Embassy, on request for showing without charge to any professional group in this country.

He had been asked a question about the possibility of malingering. He himself was not a psychiatrist and he could not speak with full authority. But in fact it had turned out that there were extremely few malingerers. When there were malingerers they were very quickly found out under the observation of such a staff as had been collected at the clinic. Instead of malingering, the deafness was very often a hysterical manifestation of personality. Sometimes it was concerned with fatigue. The tests undertaken were not considered to be 100 per cent. perfect and they were constantly being subjected to investigation. But of 500 men who were screened by this method, 50 were found to react abnormally. Of these 50, twenty-five were found to have psychogenic factors

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in their hearing loss. Psychogenic cases could be diagnosed only after a number of tests and the co-ordination of the results of such tests by someone who had an expert knowledge of them.

One speaker had used the word " grandiose " in connection with the proposed scheme. He hoped his British colleagues would not believe that they were exaggerating the importance of this in any way. It had been undertaken because of the economic importance of the proper rehabilitation of these patients. Other methods which had been pursued had failed and this up to now was the only one that had justified itself by its results.

ABSTRACTS

EAR

The Artificial Middle Ear. MAX EDWARD POHLMAN (Los Angeles). *Ann. Otol., Rhin. and Laryng.*, 1947, lvi, 647.

Deafness resulting from chronic suppurative otitis media, with defects of the membrane, is due to the absent or defective middle-ear apparatus alone. The majority of these patients have an intact functioning cochlea.

The author has attempted to replace the damaged structures by an artificial ear, imitating the structure of that of a bird where the ossicular chain is represented by a single sticklike ossicle—the columella.

Suitable cases were chosen by means of an instrument which the author calls the acoustic probe, consisting of a celluloid diaphragm with a fine bamboo probe fused to it. By touching the inner tympanic wall with the probe it was found that in certain situations, notably the regions of the foramen ovale and foramen rotundum, a marked increase in hearing was obtained.

The "artificial middle ear" consists of a small plastic cylinder moulded to the meatus and covered over at the inner end by a tense diaphragm of fish skin. A fine flexible nylon rod tipped with stent is fed through a reinforced hole in the diaphragm and brought in contact with the critical spot on the inner tympanic wall.

The author claims the prosthesis has little effect on the hearing of low frequencies, but gives an improvement of up to 30 to 35 decibels at the 1024/2048 c.p.s. levels. While admitting that "The proper fitting of the diaphragm rod prosthesis is not as simple as it seems" the author later states that the patient is taught to introduce, remove and repair the insert. No detail of how the patient is taught is given.

The audiograms of eleven cases so treated are recorded.

E. J. GILROY GLASS.

Tolerance for Pure Tones and Speech in Normal and Defective Hearing. S. R. SILVERMAN (St. Louis). *Ann. Otol., Rhin. and Laryng.*, 1947, lvi, 658.

In the course of a series of experiments to determine the tolerance level of speech and pure tone, it was found that there were three distinct thresholds of tolerance in both the normal subject and in the hard of hearing: the "discomfort" threshold, the "tickle" threshold, and the "pain" threshold. The first is rather difficult to determine, but the pure tone thresholds for "pain" and "tickle" were found to be in the level of 140 and 133 decibels respectively for all levels between 250 and 5600 c.p.s. in subjects with normal hearing. In a hard of hearing group the levels were rather lower—130 and 130 decibels.

Subsequent experiments on this same subject revealed that the tolerance levels rose systematically and significantly with successive test sessions at daily or weekly intervals to a limiting value after several sessions. This increased

Nose

tolerance was almost entirely retained for a week, after which it gradually decreased but more than half of the increase was retained for as long as twenty-six weeks in normal subjects, and thirty two weeks in hard of hearing. Increased tolerance so produced in one ear does not increase the corresponding tolerance of the opposite ear, and repeated exposure sufficient to produce maximum elevation of tolerance threshold causes at the most a small transient rise in the threshold acuity.

The data indicate that 130 decibels would appear to be the greatest useful maximum output for an electrical hearing aid. There seems to be some ground, however, for assuming that the threshold of discomfort can be raised sufficiently to make comfortable hearing possible at a level initially below the threshold of discomfort, and in selection of hearing aids, allowance should be made for this fact.

E J GILROY GLASS

NOSE

Osteomyelitis of the Basisphenoid and Basisocciput with Meningitis and Cranial Nerve Palsies as a complication of Nasopharyngeal packing for control of Epistaxis. Report of a case with Recovery. ARTHUR A SPAR, M D, HENRY L WILLIAMS, M D (Rochester, Minn.) *Arch Otolaryng*, 1947, xlv1, 473-477

The purpose in reporting this case is to call attention to the serious complications which may follow the use of nasopharyngeal packing for control of epistaxis. In this instance an abscess of the nasopharyngeal vault occurred and led to osteomyelitis of the basisphenoid and basisocciput, meningitis and cranial nerve palsies. The reporters believe this is the first such case reported in which recovery occurred.

R B LUMSDEN

LARYNX

Pathology of the Larynx. A Photographic Analysis. PAUL H HOLINGER, ALBERT H ANDREWS, GEORGE C ANISON and KENNETH C JOHNSTON (Chicago) *Ann Otol, Rhin and Laryng*, September, 1947, lvi, 583

The purpose of this paper is to present a photographic record of some of the more common types of laryngeal pathology, as seen either by the laryngeal mirror or by a direct laryngoscopy.

A detailed description of the camera, the laryngoscope and the technique used is given. The paper is illustrated by a unique series of photographs of the larynx obtained by this method, and in some cases accompanying micro photographs.

Contact Ulcer of the Larynx. II. The Role of Vocal Re education. GEORGIANA PEACHER, Ph D (Philadelphia), PAUL HOLINGER, M D (Chicago) *Arch Otolaryng*, 1947, xlv1, 617-623

The following conclusions are drawn:

1. Vocal abuse seemed to be the most consistent ætiologic factor of contact ulcer of the larynx.

2. Vocal abuse seemed to be the chief perpetuating factor of contact ulcer.

3. Contact ulcer was treated by vocal re-education with apparently better results than can be obtained by surgical excision of the ulcer and silence.

R B LUMSDEN

Abstracts

TRACHEA AND BRONCHI

Adenoma of the Bronchus. GEORGE S. McREYNOLDS (Galveston, Texas) and ROBERT E. PARRISH (San Antonio, Texas), *Ann. Otol., Rhin and Laryng.*, September, 1947, lvi, 766.

A case of benign adenoma occurring in an eight-year-old female is reported. From the history it seems reasonable to suppose that this tumour had been present since the age of three, causing symptoms of partial bronchial obstruction initially and erroneously diagnosed as allergic.

E. J. GILROY GLASS.

Primary Carcinoma of the Trachea Removed by Bronchoscopic Procedure. ARTHUR Q. PENTA (Schenectady, New York). *Ann. Otol., Rhin. and Laryng.*, September, 1947, lvi, 790.

A case of primary carcinoma of the trachea is presented in which a mistaken diagnosis of bronchial asthma was made. The pedunculated tumour mass located in the lower one third of the trachea caused an expiratory obstruction to the egress of air. This expiratory check valve resulted in bilateral emphysema and the symptoms and physical findings which followed were not unlike those commonly found in bronchial asthma. The knowledge gained from this case clearly proves the often repeated statement of Chevalier Jackson that: "All that wheezes is not asthma."

The tumour was removed bronchoscopically and the base destroyed by fulguration, after which a course of deep X-ray therapy was given. The tumour was removed in June, 1942, and at the time of writing (presumably the summer of 1947) she was in perfect health.

E. J. GILROY GLASS.

ŒSOPHAGUS

Congenital Atresia of the Esophagus with Tracheo-esophageal Fistula: A Report of Six Cases. JOSEPH A. PERRONE, M.D., WILLIAM H. FLEMING, M.D. THEODORE R. WHITAKER, M.D. (Pittsburgh). *Arch. Otolaryng.*, 1947, xlv, 5, 608-616.

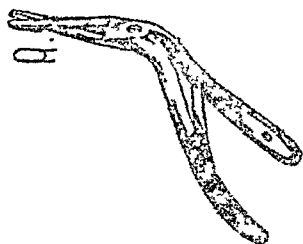
Congenital atresia of the œsophagus with tracheo-œsophageal fistula is no longer a hopeless anomaly but rather one which is rapidly becoming more and more amenable to surgical correction, since methods have been devised to prevent early death of the patient.

A remarkably constant symptom-complex is present in these cases, which should make the obstetrician or the pediatrician suspect this defect and verify the diagnosis at an early age.

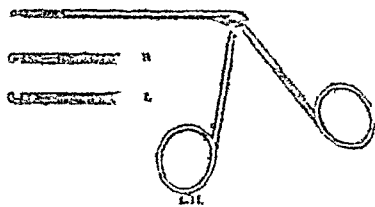
Delay in attempting surgical correction is generally fatal because of complications arising when foreign material is aspirated into the lungs and because of rapid starvation.

Six cases on record at Mercy Hospital have been reviewed all of which terminated fatally.

R. B. LUMSDEN.



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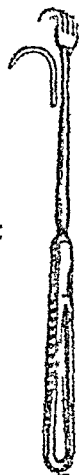
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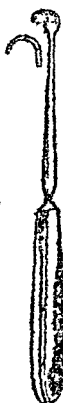
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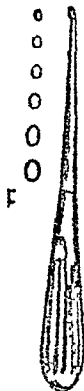
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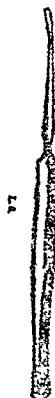
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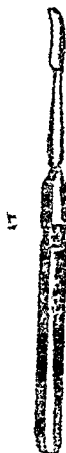
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The Journal of Laryngology and Otology

EDITED BY
WALTER HOWARTH

WITH THE ASSISTANCE OF
W. M. MOLLISON

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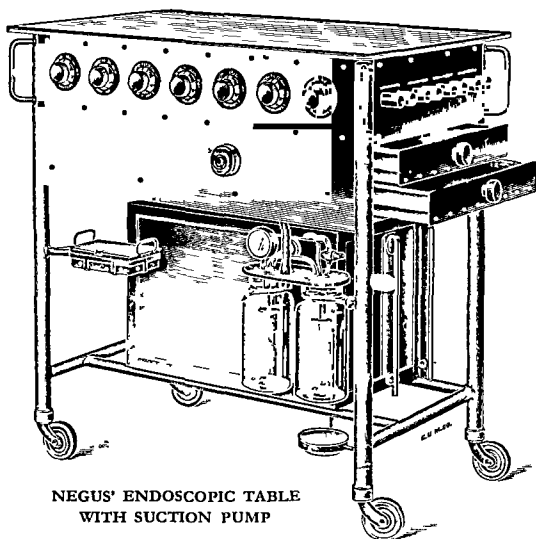
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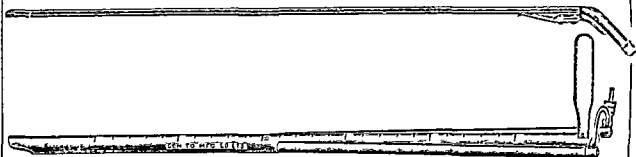
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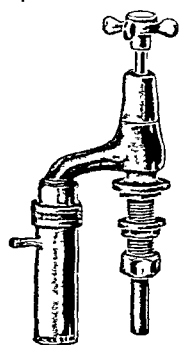
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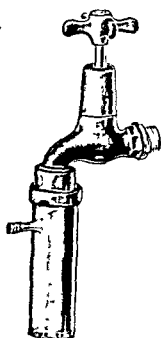
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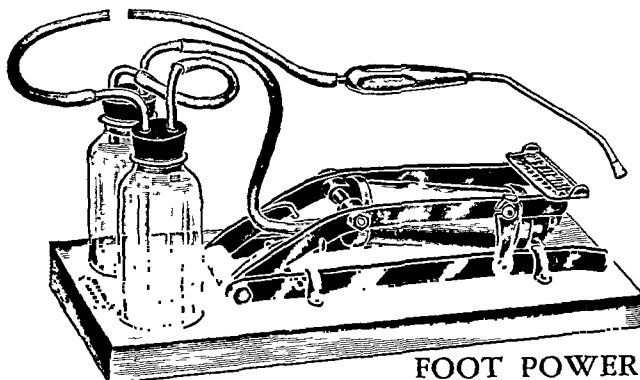


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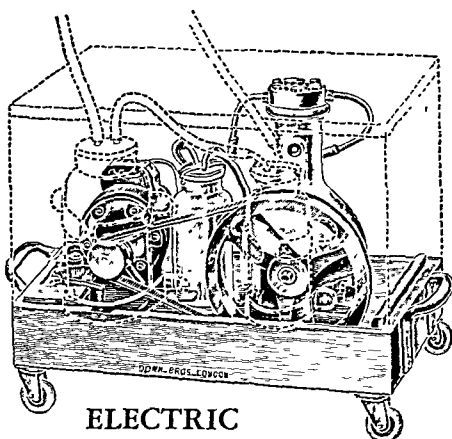
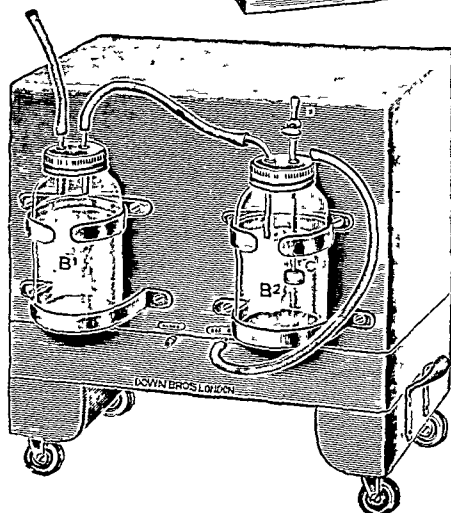


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May 1948

AUDIOGRAMS IN OTOSCLEROSIS

By WILLIAM MCKENZIE (London)

SINCE the deafness clinic at the Middlesex Hospital began in January, 1946, we have had a large number of cases of otosclerosis attending for investigation. I have had the impression that there was some relation between the age and the air conduction audiogram, and to confirm this I collected in groups the audiograms of all the otosclerotics that have been seen. The audiograms were taken by one person for the most part, and a Maico audiometer was used.

The testing room is quiet, but it is not sound proofed. It is a telephone booth, placed in a room used for no other purpose.

The audiograms were collected in groups corresponding to each decade in life, and a composite audiogram made of each group.

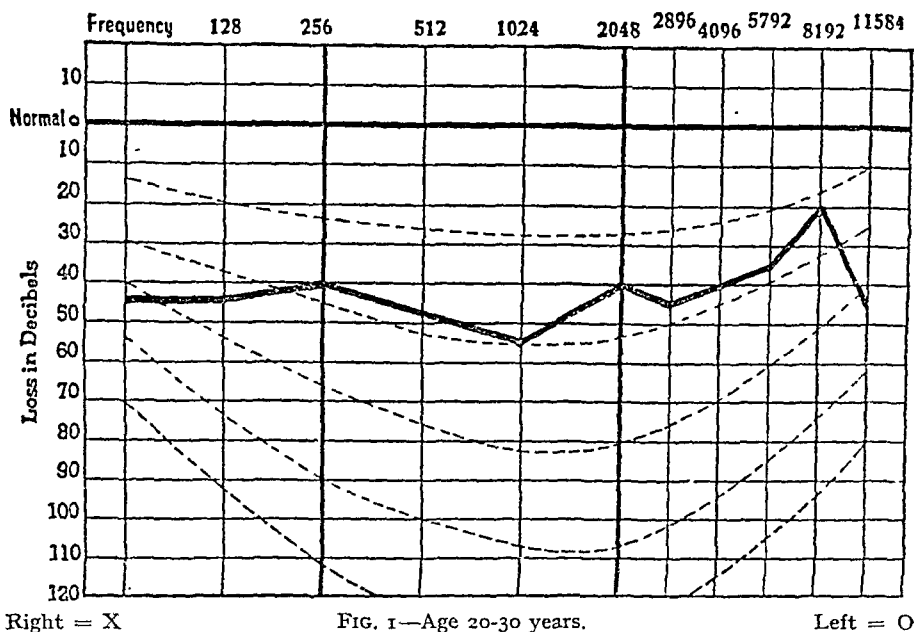
In order to keep this report as short as possible, I have not included detailed case histories.

The composite audiograms are shown at the end of this paper. In these, the audiograms of each decade are collected on one chart, and reproduce the original as accurately as possible, although there may be a difference of five decibels in some places, to avoid crowding. Slight degrees of deafness are not included, as they are seldom seen.

The composite audiograms show a good many varieties, especially in the younger age groups, as would be expected in a disease which advances so erratically. However, it seems possible to draw an average single line audiogram in each case, and these are shown below.

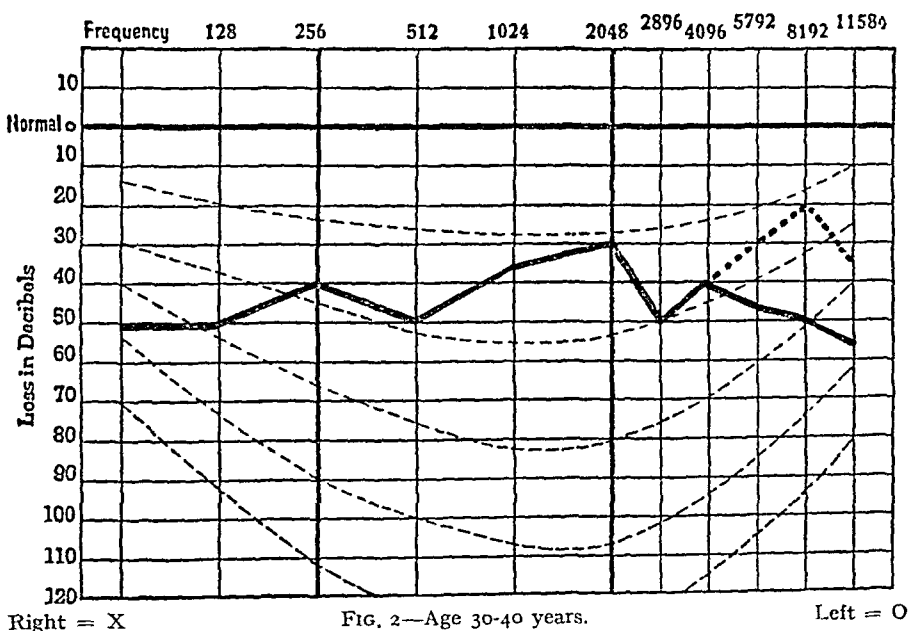
The single line has been drawn to show the characteristic curve for this age. The composite audiogram includes a number of curves of advanced otosclerosis, which may be met at any age. If the average loss at each frequency is estimated, and the resulting curve plotted, there would be no peculiarity for the age. The single line audiogram has been chosen to show the most likely curve for each age group, and while other varieties of otosclerosis may occur at any age, they are less common.

William McKenzie



The curve for the age group of 20-30 years shows a rise to 8192 D.V. where the deafness is less for high notes than it is for frequencies of 128 and 256 D.V. (Fig. 1).

The single line audiogram for the 30-40 year old group, is very like that of the 20-30 year group, but the curve is flatter (Fig. 2.) The



Audiograms in Otosclerosis

dotted line has been added, as the flat and rising curves occur about equally, so that above 4096 D V there may still be a rise, although not often enough to make it the rule

The hearing seems better at 512 D V and 1024 D V than it did in the 20-30 year group, but this is clearly accidental, and would not appear in another series of audiograms

Fig 3, 40 50 years In this group the audiogram is nearly flat to 2048 D V and with rare exceptions, it does not rise above the general level at the high notes

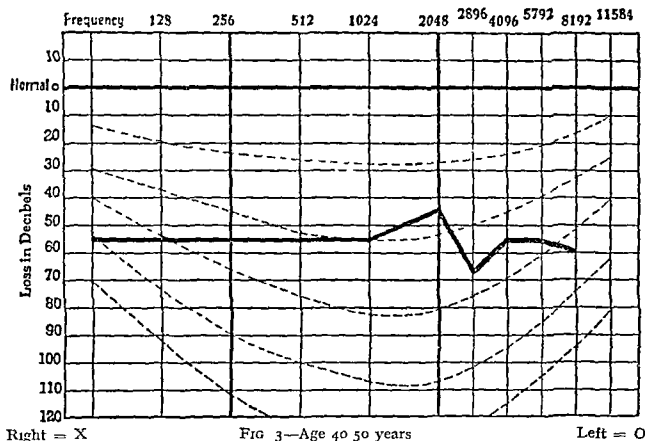


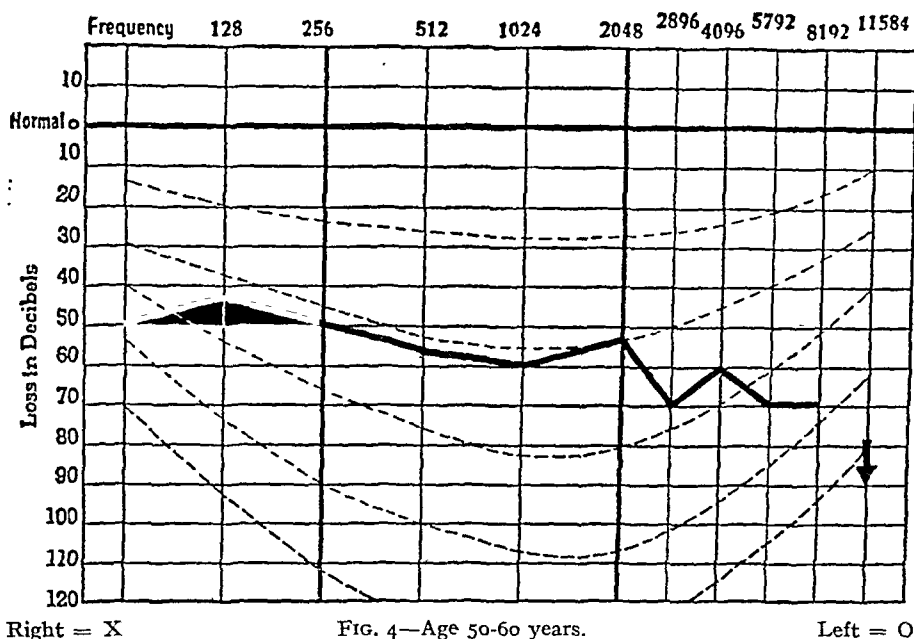
Fig 4, 50 60 years This is like its immediate predecessor, except that the loss is slightly more at each frequency It is also the most crowded composite audiogram as so many of this age attend for the first time

Fig 5, 60-70 years The single line audiogram for this group has been drawn to exclude one case with a short history, which will be discussed later The main picture, however, agrees with the series in showing a uniform loss over all frequencies, again slightly increased when compared with the younger age groups

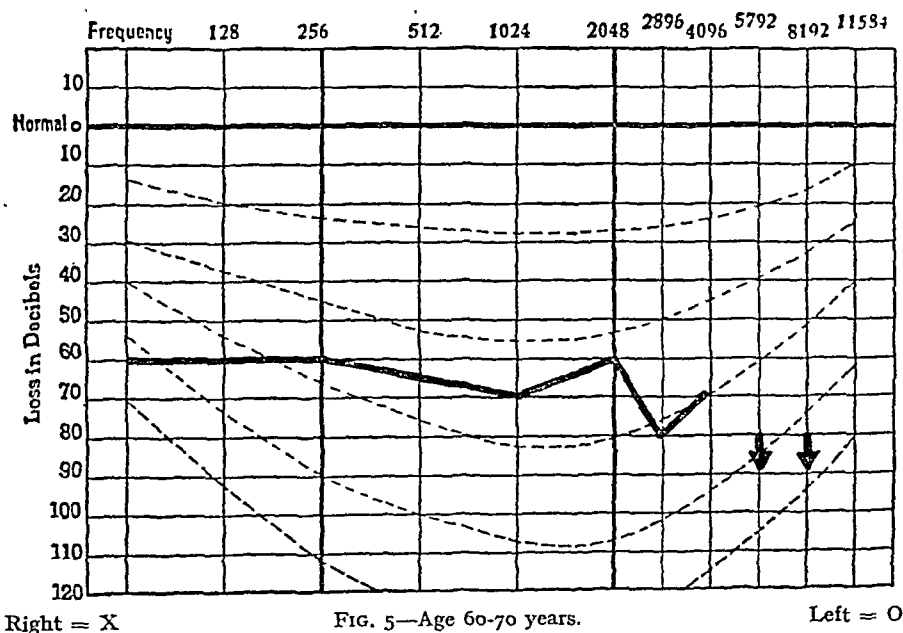
Fig 6, 70-80 years In this and in the previous audiogram, comparison with the 20-30 year group shows the total increase in deafness to have been considerable

The curves have dropped towards the high notes from 50 years onward, and although there is little difference in the groups between 50 years and 70 years, yet, when the first single line audiogram is compared with the last, a great change will be noticed

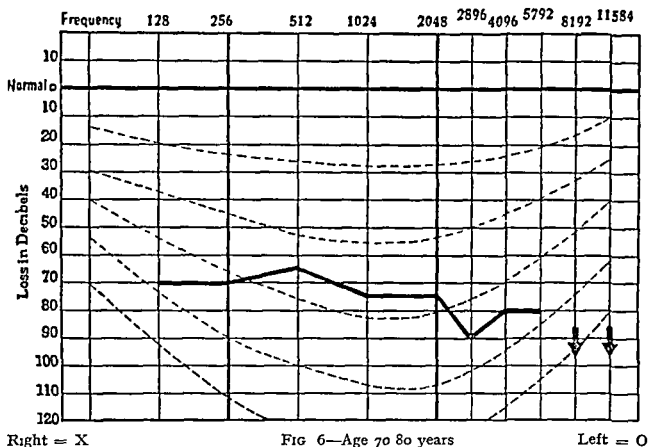
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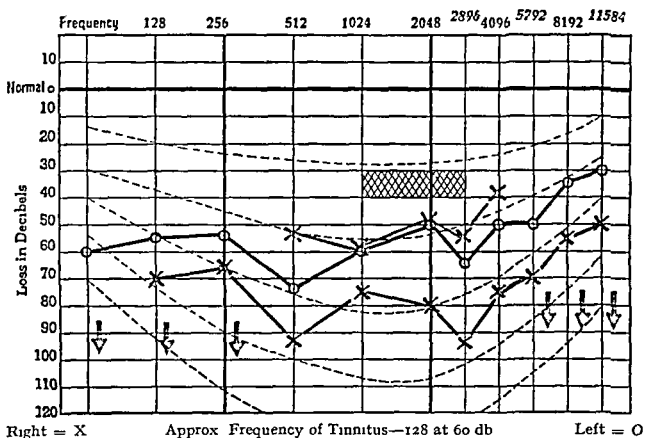
This accords with the conception of otosclerosis as a progressive disease. It also suggests that deafness due to otosclerosis does not remain stationary for long, and that it is rare for anyone to show a curve typical of one twenty years his junior.



Audiograms in Otosclerosis



This conclusion came to me rather as a surprise, for it is common for a deaf person to say that his hearing has not changed for many years. The explanation may be that a halt in progress may occur, but when the increase in deafness comes, it is large enough to equal the more usual slow



William McKenzie

advance. In any case the deaf are seldom good witnesses of their own complaint.

Examination of the single line audiograms of each decade suggests that the age alone may influence the amount of deafness, apart from the length of time the deafness has been noticed.

If this theory is true, a patient of forty years, for example, with a six years history of deafness, will show an audiogram like others of his age, although it might be expected that the audiogram would show a curve

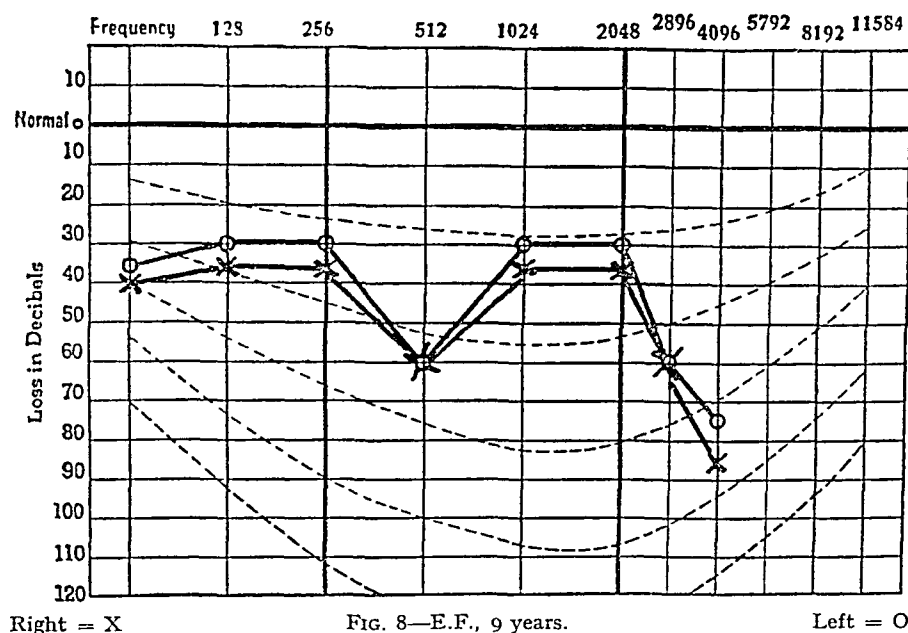


FIG. 8—E.F., 9 years.

like that of the twenty to thirty year group. The following audiogram illustrates this possibility (Fig. 7).

It is taken from a man of 41 with a six years history of deafness. It is certainly unlike the single line audiogram for the 20-30 year group, as the deafness is more profound, but the curve is, at the same time, less smooth than the typical curve for the 40-50 year group.

A short history of deafness is seldom found in old people, and the only other audiogram I could find is shown in Fig. 8.

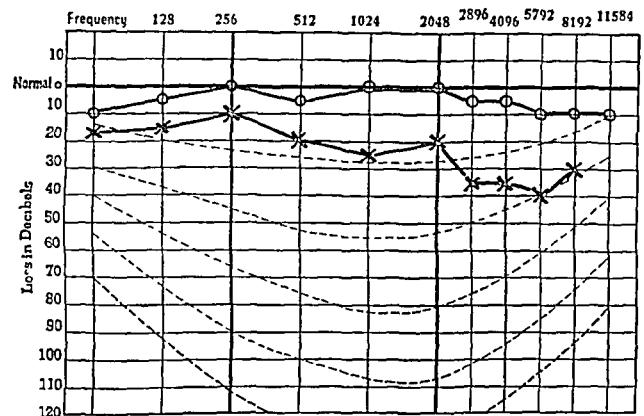
This is taken from a woman of 66 who had been deaf for nine years. It is a peculiar curve, but it is quite unlike the majority of cases who have been deaf for the same time, and who are to be found in the 30-40 year group.

It shows, in fact, that she is much deafer than is to be expected, if the length of history alone is taken into account.

Audiograms in Otosclerosis

The composite audiogram may also be helpful in investigating a case of unilateral deafness. The cause of this type of deafness is often difficult to decide, and indeed it may be impossible to do so, but unilateral otosclerosis will be less likely if the audiogram of the affected ear does not correspond to the average audiogram of the age group.

The following audiogram is from a woman of 45, with a history of deafness in the left ear for ten years (Fig 9)



Right — \

Fig 9—J H

Left = O

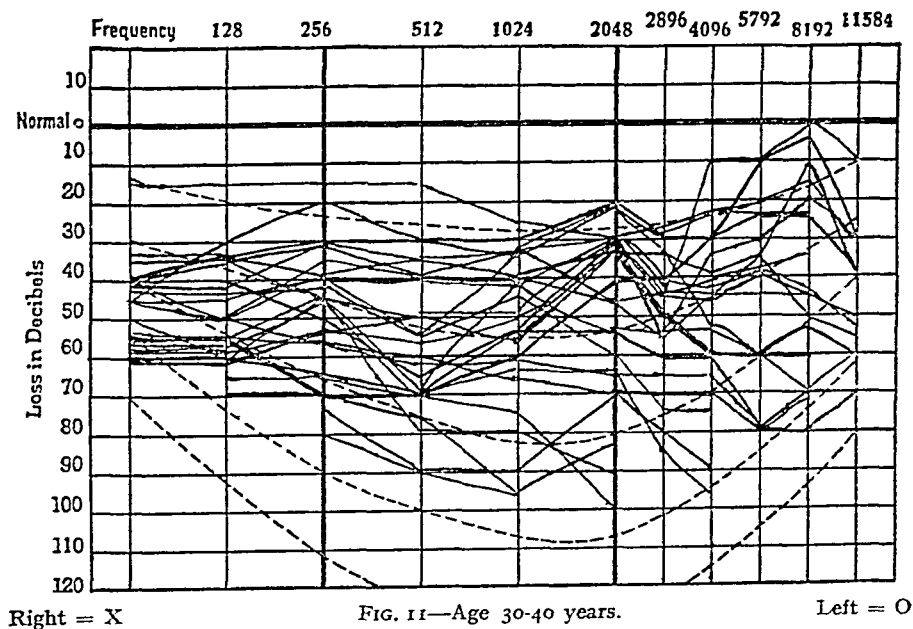
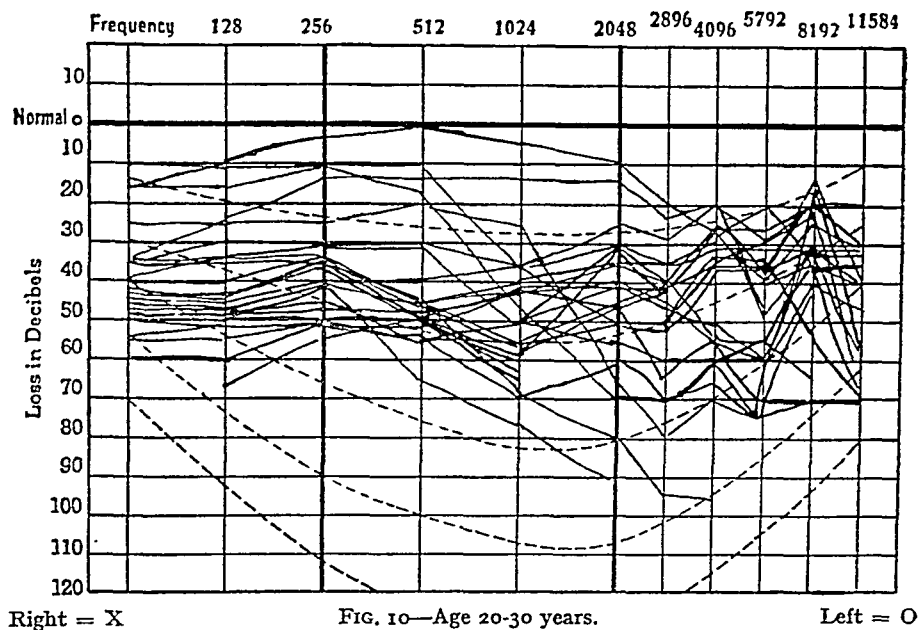
The deafness is seen to be too slight to be due to otosclerosis, when the curve is compared with the composite audiogram for this age. The most probable cause is a mild infection of the middle ear, but a case of this kind should be watched for a number of years, and audiograms taken at intervals. If the deafness does not progress, this will be added evidence against otosclerosis.

A number of these patients have been chosen for the fenestration operation, and we have found that the most suitable cases are where the air conduction audiogram shows a rising curve, those with a flat curve being less suitable, and those with a falling curve the least hopeful of all, other things being equal.

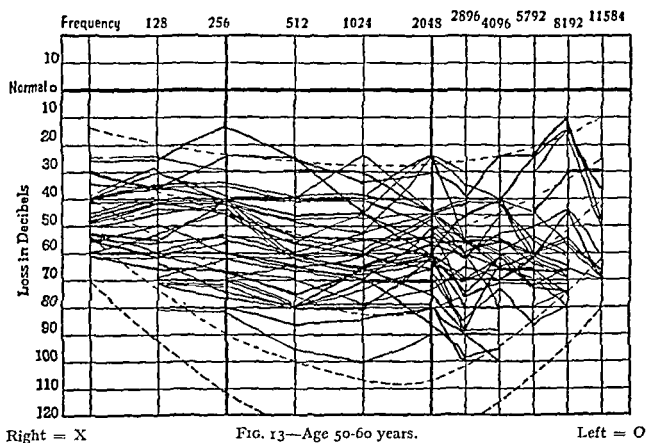
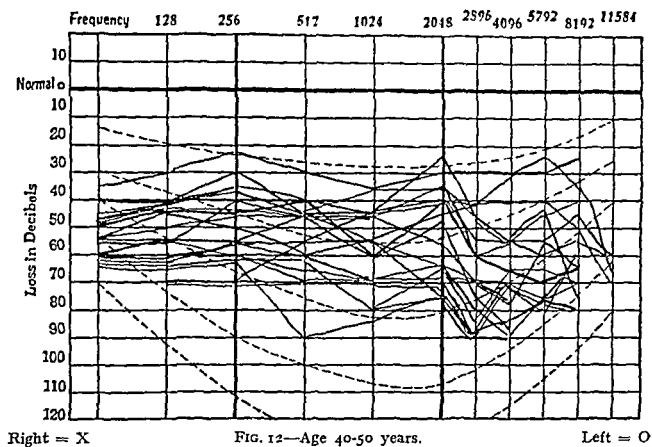
This is, of course, only a rough estimate, as several cases with a falling curve have improved, whereas there have been failures where the curve has shown a marked rise.

Improvement after fenestration occurs most often below 2048 D V. Therefore a better result may be expected in cases with a rising curve,

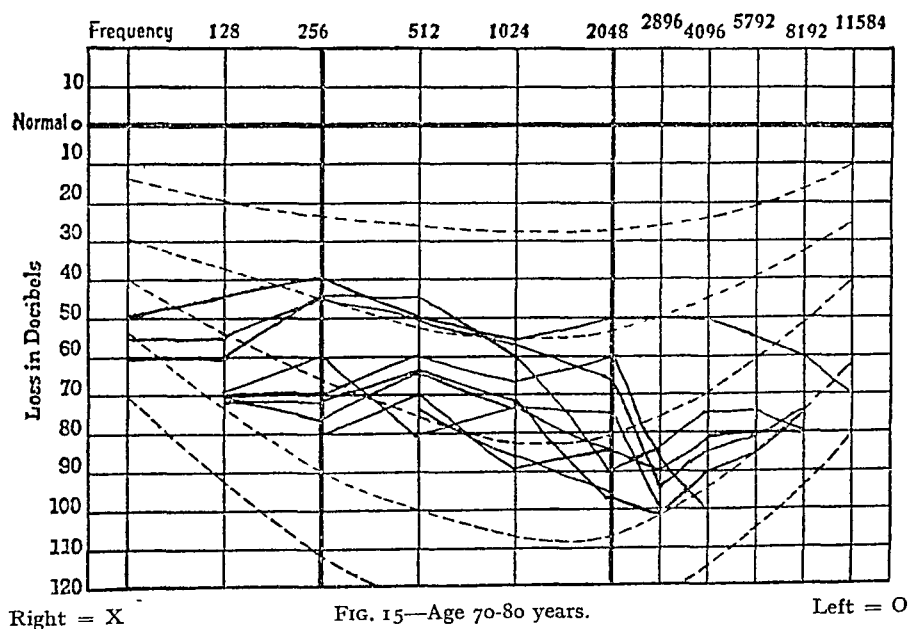
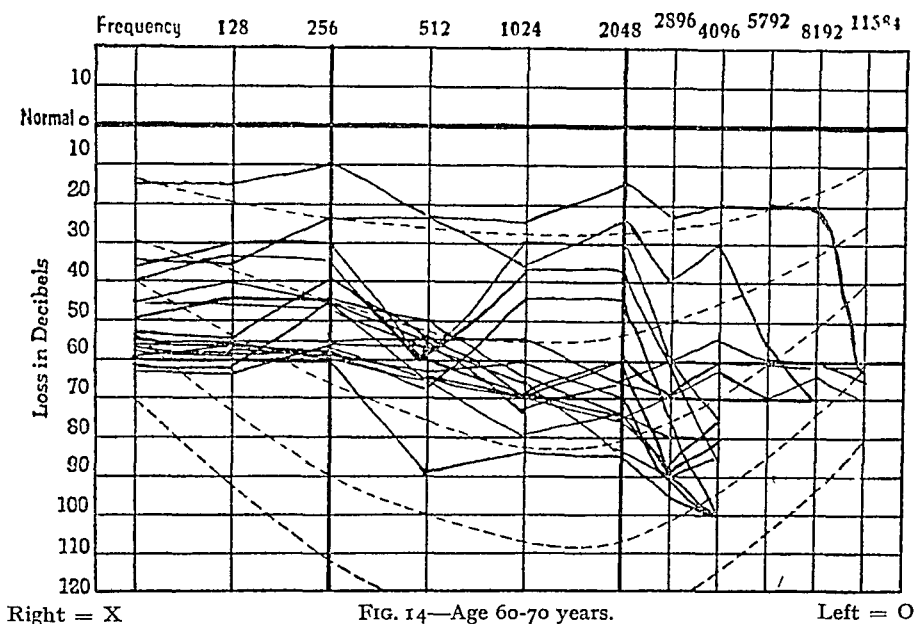
William McKenzie



Audiograms in Otosclerosis



William McKenzie



Audiograms in Otosclerosis

simply because they already possess good hearing above 2048 D V , and the addition from fenestration is exactly in the place where hearing was poor before operation

It is more probable, however, that the true explanation is not so simple. The audiogram with a curve rising to the high notes may be, in fact, only a sign that the progress of the disease has been slight, and that benefit from operation occurs for this reason.

Simson Hall has said that the most suitable cases for fenestration are those under 25. As a rising curve in the audiogram is most common at this age, the majority of suitable cases will certainly occur here, but there will, however, be a few cases of 40 and even older, where the audiogram is better than would be expected for the age group, and in consequence fenestration will hold out promise of success.

I must thank Mr J P Monkhouse for permission to record the audiograms of these cases.

Summary

(1) A comparison is made between air conduction audiograms in otosclerosis at different ages.

(2) Otosclerosis, as shown by the audiograms, is steadily progressive, and a halt of more than 15 years is unusual.

(3) The age may influence the hearing loss, apart from the length of history.

(4) The shape of the air conduction audiogram may prove to be more help in choosing cases for fenestration, than age alone.

REFERENCE

SIMSON HALL 1946 *Brit med J* (November 2nd)

CEREBELLAR ABSCESS, ACUTE, OTOGENIC

A NOTE ON THE EARLY DIAGNOSIS AND DRAINAGE WITH SOME CASE RECORDS

By N. ASHERSON (London)

HE is a fortunate surgeon who has hitherto escaped the mortifying experience of having his patient, with but few prodromal symptoms or signs, relapse suddenly, and unexpectedly, and succumb within a few hours to a cerebellar abscess (usually of huge dimensions) hitherto unsuspected or only diagnosed when too late to save the patient's life. That this occurrence is not infrequent, indicates a complete disregard of the early symptomatology and signs of such a complication, which often occurs during the early period, after a radical mastoid operation for an apparently indolent, uncomplicated, chronic otorrhœa.*

An otogenic cerebellar abscess may develop and increase in size insidiously, attaining huge dimensions with few signs or symptoms other than a frontal and/or occipital headache, which may be slight, intermittent and only sometimes accompanied by vomiting. Periods of freedom from headaches are common. The patient is apparently well, may appear normal, being alert mentally and co-operative. The temperature and pulse give no indication of even a large abscess: but careful daily routine neurological examination will reveal sooner or later persisting nuchal rigidity. The key to the diagnosis in the early stage rests on a spinal tap, with registration of the pressure of the cerebrospinal fluid and a complete differential cell count. Nuchal rigidity not accountable for by the slight change in the cell content of the cerebrospinal fluid must be interpreted in terms of a cerebellar abscess.

Records of four consecutive successful cases have been published (Asherson, 1942) indicating points enabling an early diagnosis to be made and the details of the operative treatment adopted.

The records are appended of three more consecutive cases, in two of which operation effected a cure, and in one of which a spontaneous cure resulted, the latter being the only case familiar to me in the literature.

* When an adult with long-standing chronic otorrhœa (associated with granulations, polypi or cholesteatoma) long neglected, attends again for treatment, it is prudent to enquire *why* the patient attends *now*. It is possibly because there has been some subtle difference of which the patient has now become aware—the harbingers of the impending intracranial complication. Such a case should be carefully observed in the post-operative period when the complication impending (when *first* attending) will be detected earlier than might otherwise be the case.

Cerebellar Abscess, Acute, Orogenic

These case records substantiate the previous findings for full details of which, together with documentary evidence upon which the views were adumbrated, reference must be made to the previous paper (1942)

Attention was drawn to —

- (a) The significance of the pressure reading of the cerebrospinal fluid in the diagnosis between a cerebellar and a cerebral abscess
- (b) The characteristic cell count of the cerebrospinal fluid
- (c) The significance of the "syndrome de discordance"

In particular, the following law was postulated to differentiate between a temporal lobe abscess and a cerebellar abscess —

- (1) Where the cerebrospinal fluid pressure in the tranquil patient was below 200 mm of water, the suspected brain abscess was below the tentorium (cerebellar)
- (2) Where the pressure was above 300, the abscess was above the tentorium

The cases since encountered confirm the postulates previously adumbrated

Two further case records are appended as a corollary to show the dire results due to delay in diagnosis, coupled with a still further delay in establishing adequate drainage, through the most suitable access—viz Trautmann's triangle. These cases were not under my care. A third case is recorded to show that even where the infection from the ear has been observed to spread to the posterior cranial fossa the subsequent brain abscess which developed, arose *not* in the cerebellum, but in the temporo-sphenoidal lobe

Early Diagnosis

It is necessary to emphasize the necessity in a *suspected* case of cerebellar abscess for a complete neurological examination, repeated daily or if necessary more frequently. In particular to diligently search for —

- (a) Persisting nuchal rigidity—the most consistent, not to mention early, sign of a cerebellar abscess. It was present in 100 per cent of my cases. This nuchal rigidity is early, is persistent, and bears no relation to the fluctuations in the cell count, or the pressure of the spinal fluid. The less the pleocytosis, the greater the diagnostic significance of such rigidity. The detection of this important physical sign is the keystone to the early diagnosis.
- (b) Nystagmus. Too much must not be inferred from the type or the excursions of the nystagmus. What is of clinical importance is the detection of a pendular coarse nystagmus, of sudden and *recent onset*, which had been absent at all the previous examinations (see Case I)

- (c) Arm symptoms. These are homolateral and demonstrable as past-pointing, ataxy and, most important of all, *dysdiadokokinesis*.

The invariable sequence is, (1) the case presents with persisting nuchal rigidity (suspicion of an abscess), and, (2) with the onset of dysdiadokokinesis (confirmation of the abscess) the diagnosis becomes certain.

This applies to all cases where the infection has spread to the posterior cranial fossa as evidenced by the previous operative disclosure of the perisinus abscess, with or without pachymeningitis externa, with or without thrombophlebitis of the sigmoid sinus, whether obliterative, by pressure, or by an obturating thrombus or collapse of the sinus lumen—all of which I have encountered.

(The co-existence of sinus thrombophlebitis of the sigmoid sinus may obscure the presence of a cerebellar abscess but this is unlikely if the observer is alive to the possibility.)

A bewildering galaxy of cerebellar signs may develop suddenly within a few hours as in case I. Here, when the case was examined at 4 p.m., only the daily observed nuchal rigidity was detected. At 6 p.m. the full blown cerebellar clinical syndrome developed—and operation at 10 p.m. I drained a huge cerebellar abscess. From which it may be inferred and my experience bears this out—that the cerebellar physical signs develop at a much later stage after the abscess has already formed, and in fact are late, one might almost say, terminal signs. The abscess is always ahead of the physical signs, and therefore much larger at operation than the physical signs would lead the inexperienced to expect. A cerebellar abscess with *definite cerebellar signs* should always be easy to locate. The region of the cerebellum where the otogenic abscess develops is constant, is notoriously a “silent” region, and the abscess there may attain huge dimensions with only a few slight cerebellar signs for a long period—aptly described as the prolonged silent prodromal period. But signs there are for those who would seek for them long before the “cerebellar” syndrome makes its appearance and of these I would again stress the following:—

- (1) The presence of persisting nuchal rigidity—not necessarily obvious, but to be diligently and duly sought for.
- (2) The manometric reading of the cerebrospinal fluid, and the complete cytology of the fluid for which a lumbar puncture is necessary. In the absence of this investigation, it is not possible to diagnose the otogenic cerebellar abscess in its early (latent) stage—the stage at which immediate operation and suitable drainage should save 100 per cent. of cases. The danger of withdrawal of small amounts of cerebrospinal fluid has been exaggerated and applies to the case observed at a late stage of the disease.

Cerebellar Abscess, Acute, Otogenic

The nuchal rigidity, the pressure and all cytological changes of the cerebrospinal fluid must be considered together. Generally speaking nuchal rigidity is the sign par excellence upon which the clinical diagnosis of meningitis is established, and the diagnosis is clinched when it is found that the cerebrospinal fluid contains hundreds or thousands of cells—almost one hundred per cent polymorphonuclear leucocytes.

But in a case of the cerebellar abscess (even before any cerebellar signs become overt) the cytology of the cerebrospinal fluid varies surprisingly little from normal—with but 10 to 20, or 50 cells only, mainly lymphocytes. This may be termed *minimal changes*. In other words the case is clinically one of otogenic meningitis, but the cytology of the cerebrospinal fluid fails to pathologically confirm the clinical diagnosis. This paradox of pathology is pathognomonic of the cerebellar abscess.

Where the cerebellar abscess is secondary to an *acute otitis and mastoiditis*, complicated by otogenic meningitis (Case I), though gross cytological changes occur when the mastoiditis and meningitis develop, these cytological changes recede so rapidly that by the time the cerebellar abscess has developed, the cerebrospinal fluid changes have become minimal—but the *nuchal rigidity persists*. Thus paradoxical improvement in the cerebrospinal fluid with a patient who is not improving clinically, or, if the delay is countenanced long enough, is permitted to *deteriorate* clinically, is termed the syndrome de discordance and is diagnostic of a brain abscess.

MANOMETRIC RECORDING OF THE CEREBROSPINAL FLUID PRESS AND ITS SIGNIFICANCE IN A SUSPECTED CASE OF OTOGENIC BRAIN ABSCESS

My experience (1942) has drawn attention to the significance of the pressure of the cerebrospinal fluid in otogenic brain abscess, and I adumbrated a clinical rule which may be stated thus —when the pressure of the cerebrospinal fluid is measured with the patient tranquil, a reading of under 200 mm of water indicates the abscess to be intratentorial (cerebellar), a reading of over 300 mm of water indicates the abscess to be above the supratentorial (temporo sphenoidal).

It is interesting to review the cases attached to this paper in the light of this observation.

- Case I Pressure of cerebrospinal fluid, 140 mm of water
- Case II Pressure of cerebrospinal fluid, 100 mm of water
- Case III Pressure of cerebrospinal fluid, 180 mm of water
(Spontaneous recovery)
- Case IV Not under my care
- Case VI *Temporo-sphenoidal lobe abscess*, 250 mm water

This further experience confirms my findings. One could say that if the pressure is *over 300 mm. of water*, it is in favour of a supratentorial abscess.

CLINICAL CLASSIFICATION OF THE ACUTE OTOGENIC CEREBELLAR ABSCESS.

Group 1. An acute or chronic ear case with, (1) *persisting nuchal rigidity*, and, (2) *minimal cerebrospinal fluid changes*.

This is very suggestive of a cerebellar abscess and daily complete neurological examinations are necessary, seeking for, in particular:—

(1) Past pointing or arm.

(2) Ataxy of arm.

(3) Dysdiadokokinesis.

The onset of these is an indication for immediate operation for a cerebellar abscess.

Group 2 (*exemplified by Case I*). The case—usually an acute ear—presents with otogenic meningitis (thousands of cells per cm.); the cerebrospinal fluid changes resolve but the *nuchal rigidity persists*.

Here again repeated daily neurological examinations are necessary, with repeated lumbar punctures to determine the pressure and cytology of the cerebrospinal fluid. The syndrome de discordance dominates this group.

If these observations are borne in mind, the early diagnosis of the cerebellar abscess can be established, early drainage instituted, and a high recovery rate secured.

Co-operation with Neurologist and Otologist; Decision When, How and Where to Operate

The diagnosis of the *acute otogenic cerebellar abscess* (as any of the other intracranial otogenic complications*) should be established by the ear surgeon himself, and though the co-operation of the neurologist, and neuro-surgeon is essential to establish, or negative, the clinical neurological findings, the decision as to when and where and how to drain the cerebellar abscess must, in the final judgment, be left, in my opinion to the otologist who has had the care of the case and has already probably operated on the mastoid. I am not at one with those who advocate the immediate abandonment of the case to the neurological surgeon, as soon as the diagnosis of cerebellar abscess is established.

In support of this, I attach the record of cases appended in which recovery ensued in all cases under my own personal care.

In these enlightened days of the sulfa drugs and penicillin, and an otologist, fully aware of the necessity for early and appropriate treatment

* (1) Extra-dural abscess, (2) sinus thrombophlebitis, (3) meningitis, (4) temporal lobe abscess, (5) petrositis.

Cerebellar Abscess, Acute, Otogenic

of all ear infections, all otogenic complications are becoming rare, and especially the cerebellar abscess. It is given to few surgeons to see and treat many of such cases in the years of his active life ; hence of necessity the number of case records of any individual surgeon must be few.

It is interesting to speculate on the present progressive trend of surgical departmentalization. We are unwittingly witnessing the twilight of the oto-rhino-laryngological gods. The twin birth of the neuro-surgeon and the thoracic surgeon (now flourishing adult gemini) has produced two unsaturated specialities, the devotees of which can only fulfill their complete expanding mission by absorbing parts of other pre-existing specialities. The marriage (in my opinion, most decidedly for the *better* and not the worse) is inevitable of the ear and nasal surgeon with the neuro-surgeon, and the throat surgeon with the thoracic surgeon. This spontaneous cleavage of the otorhinolaryngologist is a natural one. Most of the infective intracranial lesions curable by surgery (excluding traumatic and war causes) occur in the province of the ear and the nasal surgeon, being secondary to infections of the ear and the nasal accessory sinuses. For the neuro-surgeon to deal with the intracranial complications alone and be unable to deal with the primary focus (and *prevent* complications) is an anachronism which this marriage alone can overcome and the sooner the nuptials are celebrated, the better. Those planning the future training of the specialist should bear these inexorable facts in mind and prepare for it.

Association with other Intracranial Complications

Intracranial otogenic complications are notoriously multiple : one or two or more may co-exist, or follow one another, and the case records are invariably lengthy, and reflect the prolonged daily observations which become necessary, the many investigations and the numerous operations undertaken before the case is piloted into the convalescent and recovery stage. All this may sound confusing, but the stages usually dovetail into one another, logically to the clinician who is aware of what he is searching for ; it is in this type of case where experience is invaluable.

The common co-existing sequence is :—

mastoiditis	}	together with or without meningitis
peri-sinus abscess		
pachymeningitis externa		
thrombophlebitis.		

This is followed at a later stage by cerebellar abscess.

Posterior Fossa infection and extension cerebellum may rarely be in Temporal Lobe

The extension of the mastoid infection into the posterior cranial fossa as shown by the disclosure of a peri-sinus abscess etc., does not

TABLE I (9 cases)—SUMMARIZING CASE RECORDS, ESPECIALLY CARDINAL PHYSICAL SIGNS AND CEREBROSPINAL PRESSURE AND CYTOLOGY.

	Case I.	Case II.	Case III.	Case A.	Case B.	Case C.	Case D.	Case 4.	Case 5.
Causal acute (A.S.O.M.) or chronic suppurative otitis media (C.S.O.M.) ..	C.S.O.M. (L)	C.S.O.M. (R)	A.S.O.M. (R)	A.S.O.M. (L)	C.S.O.M. (L)	C.S.O.M. (R)	C.S.O.M. (L)	A.S.O.M.	C.S.O.M. (R)
Duration since 1st symptoms and definite diagnosis ..	14 days	14 days	14 days	10 days	14 days	14 days	21 days	35 days	some weeks
Temperature ..	Normal	Normal	Normal	100	97.98	100	101	Normal	+ + +
Pulse ..	60	50-60	Normal to 60	56	64	68	100	Normal	
Respiration ..	8	—	—	—	—	—	28	—	
Drowsiness ..	+ +	0	0	0	—	Comatose + +	—	+	
Nuchal rigidity ..	+	Slight	+	+ + +	+ + +	+ + +	+ +	+ +	+ +
Papilledema ..	+	0	? +	0	0	0	0	+	
Facial lesion (homolateral) ..	0	0	0	+	—	0	+	+	
Nystagmus ..	+	+	+	+	+	—	+	—	+
Past pointing ..	+	+	+	+	+	—	+	+	+
Ataxy homo-lateral arm ..	+	+	+	+	+	—	+	+	+
Dysidiadochinesis ..	+	+	+	+	+	Unconscious	+	+	+
Limb homolateral (hypotonia) ..	?	+ +	—	+	—	—	0	+	
Abdominal reflex ..	—	Brisk	Brisk	—	+	—	+	+	
Knee jerks ..	—	+ +	+	—	—	+ +	+		
Plantar response ..	—	Extensor	Flexor	Flexor	Left extensor	Extensor (R & L)	Bilateral flexor	Bilateral extensor	
Lumbar puncture ..	140 mm. water	100	140	130	180	140	On admission 2 weeks later	130	120
P.A. Cells ..	14 cells	1,000 cells	48 cells	49 cells	18 cells	311 cells	17 cells	30% Lymphs.	18 cells
	90% Lymphs.	Chiefly polys.	70% Lymphs.	81% Lymphs.	All Lymphs.	79% Polys.	95% Lymphs.	100% Lymphs.	20% Lymphs.
			30% Polys.			19% Lymphs.			80% Polys.
Result (Post-operative) ..	Recovery	Recovery	Spontaneous	Recovery	Recovery	Recovery	Recovery	Died	

Cases I-III.—Recorded in this paper.

Case A. to D.—Are cases I to IV, recorded by me in 1942.

Cases 4 and 5.—Cases seen in consultation only, summarized in this paper.

Cerebellar Abscess, Acute, Otogenic

necessarily mean that a brain abscess will, if it develops be located in the cerebellum—it usually does—but may, as in Case 6 be located in the temporal lobe.

Isolation of Extra-Dural Suppuration

There may be no actual continuity between the infection (empyema or cholesteatoma) in the mastoid antrum in a case of chronic otorrhœa (where in 80 per cent. of cases the mastoid process is sclerotic), and the infection in the posterior cranial fossa. Hence, in a *suspected* intracranial complication, or in a case of meningitis (Case 2) secondary to chronic otorrhœa, it is always necessary to deliberately expose the dura of the middle and the posterior cranial fossa, otherwise a chance of saving life may be missed.

Urgency for Operation

The onset of cerebellar symptoms, in a case under observation for a suspected brain abscess, is an indication for immediate surgical intervention. Delay is dangerous and the surgeon is toying with the patient's life by countenancing any delaying action or further temporizing.

Temporizing is justifiable while the diagnosis is being established and only for such time. The diagnosis of an otogenic cerebellar abscess is synonymous with an immediate surgical exploration. Well has it been written by Eagleton, "The surgeon who postpones an operation for brain abscess to suit his personal convenience starts with a handicap that too often results in the death of his patient—a death frequently avoidable."

TABLE II

PRESSURE CHANGES IN THE CEREBROSPINAL FLUID IN CASES OF ACUTE OTGENIC CEREBELLAR ABSCESS WITH CYTOLOGICAL CHANGES

Cases 6 to 10 were published in my paper in 1942

Note all these figures support the law that with a lesion below the tentorium, the pressure of the fluid is invariably below 200 mm water. A corollary to this is that with a supratentorial lesion, the pressure is invariably over 300 mm water

Case	Age	Pressure	No of Cells	Lymph	Polys
		mm water			
1	30	140	14	90%	10%
2	15	100	1,000	6%	94%
3	11	140	48	70%	30%
4	6	130	30	Mainly	
5	30	120	18	20%	80%
The following were previously published in my paper in 1942 (portions)					
A	6	103	43	81%	19%
B	17	180	28	100%	
C	27	140	311	19%	79%
D	12	140	17	95%	5%
L.	10	Slightly raised	82	83%	17%

Case Records

Cases I and II form the fourth and fifth cases in a consecutive series of six cases of cerebellar abscess, with early diagnosis and immediate drainage through Trautmann's triangle, all with recovery.

Case III is one of spontaneous recovery.

Cases IV and V. Delayed operation and death.

The cerebrospinal fluid findings confirm the syndrome to which attention was drawn in my Hunterian lecture on the otogenic cerebellar abscess with special reference to the posterior cranial fossa cerebrospinal fluid syndrome (1942).

I am indebted to Sir Allen Daley, F.R.C.P., M.O.H., of the London County Council, and Mr. J. M. Whigham, M.S., F.R.C.S., Medical Superintendent of St. Andrew's Hospital, Bromley-by-Bow for referring these cases to me and permitting me to use the case records.

CASE I.—Cerebellar Abscess (Right), presenting initially as a case of otogenic meningitis secondary to a transient acute otitis media (which apparently resolved spontaneously): Sulphathiazole therapy: immediate Mastoid operation: ten days later physical signs of right cerebellar abscess: Immediately drainage through Trautmann's triangle: Recovery.

This case displays the characteristic posterior fossa cerebrospinal fluid syndrome, and the syndrome de discordance confirming clinical observations recorded previously (Asherson, 1942).

18.12.42

Male, aged 30, was admitted to St. Andrew's Hospital (L.C.C.) clinically, as a case of meningitis. Five days previously he had been admitted to a London hospital with an "acute ear" and discharged. For the past forty-eight hours he has had photophobia, headache, with a stiff and painful neck. During this time, his temperature was normal, but was now sub-normal with bradycardia, the pulse varying from 48 to 56.

He lies on his back; answers questions promptly and correctly, without repetition or slow cerebration; no amnesic aphasia; right ear deaf, scanty discharge in depth; no perforation observed; no mastoid tenderness or swelling. The pupils are equal and react to light; fundus oculi normal; no facial lesion; no ataxy; no dysidiadokokinesis; no abdominal reflexes; left knee jerk exaggerated. Well marked nuchal rigidity. The right leg had been amputated; no plantar response.

Lumbar Puncture

On admission pressure about 120 mm. water; 51 cells—81 per cent. lymphocytes; proteins, 30 mgr.; chlorides, 730 mgr.; mixed organisms. No tubercle bacilli.

2nd Lumbar Puncture, 18.12.42

Pressure 200 mm. water; 21 cells, mainly lymphocytes.

Clinical Diagnosis

Otogenic meningitis, no cerebellar or temporal lobe signs. Probably secondary to petrositis; for X-ray of the mastoid and the petrous bone.

Cerebellar Abscess, Acute, Otogenic

Comment

The onset of signs of "clinical meningitis", (or rather well marked nuchal rigidity) following an ear infection (transient or persisting) not accounted for by the actual changes in the cerebrospinal fluid (e g in this case only 51 cells 81 per cent lymphocytes) must be attributed to an otogenic intracranial brain abscess. The pressure of under 200 mm water relegates such an abscess to the intratentorial (cerebellar) region (Asherson, 1942). Cerebellar signs should be sought for and on the appearance of any one e g ataxy of homo-lateral arm or dysdiadokokinesis should lead to immediate exploration.

Subsequent events proved this interpretation (in retrospect) to be correct. The X-ray of the petrous bone disclosed no pathology.

19 12 42, Operation

Right radical mastoid operation. Sclerotic process. Fluid in mastoid antrum. No cholesteatoma. Sinus and dura not exposed.

26 12 42

Seen three days ago by neurologist (Dr E A Blake Pritchard) who found papilloedema, ataxy of the right arm, and right arm dysdiadokokinesis.

Lumbar Puncture

Pressure 140. Fluid clear.

Cells 14, 90 per cent lymphocytes, 10 per cent polymorphs.

Protein 30 mgr, chlorides 730 mgr. No organism. No T B.

Considered a cerebellar abscess, but interference not advised as "the patient was improving."

Seen To day (N A)

Temperature normal all the time (not sub normal). Not wasted, no headache, no vomiting. Pulse 60-100, was 120. Lies curled on left side, incessant yawning, alert, co-operative, no amnesia, no slow cerebration, no facial paresis, right external rectus paralysis. Nuchal rigidity marked. Pupils dilated, equal, react to light. No spontaneous nystagmus, but transient pendular on looking left. Bilateral papilloedema. No diplopia. Right arm ataxy (finger to nose). Dysdiadokokinesis.

Diagnosis

Right cerebellar lesion for operation, staff advised to closely observe respiration.

27 12 42, (1 30 a m)

Respiration dropped to 8 per minute.

Comment

Cerebellar signs, e g right arm ataxy—no paresis—dysdiadokokinesis and papilloedema, have now been present for three days. The three lumbar punctures show a constant pressure reading of under 200 mm water, an improvement in the cerebrospinal fluid, coincided with a worsening in the patient's condition (the syndrome de discordance) all these pointed to cerebellar abscess. The slowed respiration with commencing respiratory paralysis indicated that the lesion is progressive. The last lumbar was performed three days previously. Note the continued absence of headache, earache, vomiting and wasting. No mental torpor, the leading sign was the pronounced nuchal

N. Asherson

rigidity. The right ear was an acute transient condition. At the time of the mastoid operation no active inflammation or pathology was disclosed in the mastoid. The history of fourteen days—all since first earache. This patient has had 78 grammes of sulphathiazole over eight days. The temperature has always been normal ; *not* sub-normal.

27.12.42

Breathing very slowly and cyanosed especially as anæsthetic was commenced.

Operation 10 a.m.

Without any anæsthesia—mastoid wound reopened ; additional transverse incision posteriorly ; dense mastoid cortex gouged away ; sigmoid sinus exposed first by the use of the gouge and mallet, then by nibbling away further bone with forceps ; junction of sigmoid with lateral sinus exposed ; sinus engorged and dilated ; packed off with a BIPP plug above and a similar one below ; bone of Trautmann's triangle removed chiefly by forceps but also with gouge and mallet ; dura of the posterior cranial fossa normal *not* under tension. No extra-dural abscess—no pachymeningitis externa ; an area about one half inch exposed ; wide bore record needle syringe inserted in a postero-medial direction. At a depth of one inch pus was aspirated ; the 5 c.c. syringe being rapidly filled by aspiration. The syringe was detached, pus permitted to well out continuously and spontaneously through the needle ; the mastoid cavity was filled to overflowing twice (about 2 ozs.). *At this stage the breathing was restored—deeper and more frequent and colour improved.* When pus ceased to flow the dura was incised transversely with a tenotome (it was very tough), at the point where the needle had transfixed it. The needle was withdrawn ; the dura incision was enlarged about half an inch (transversely) ; no hernia cerebellar ; no pus escaped ; sinus forceps inserted into abscess cavity, no pus ; cavity aspirated with No. 4 catheter ; tube inserted ; mastoid cavity packed with BIPP, the pinna being folded well forward ; some bleeding in the cavity controlled by BIPP plug. Time, 40 minutes ; much time taken with "induction" as patient did not breathe and ultimately the operation was commenced forthwith in view of the onset of cyanosis and commencing respiratory paralysis with an unobstructed airway. (It is important to pack off the sigmoid sinuses before any exploration.)

27.12.42

Better ; conscious ; respiration 20 ; pulse 120.

Comment

Note, onset of bilateral papilloedema though cerebrospinal fluid pressure was only 140 mm. water.

28.12.42

Well ; conscious ; alert ; temperature ; pulse and respiration normal ; nuchal rigidity only slight ; no right arm ataxy or dysdiadochokinesis. No abdominal reflexes ; no external rectus palsy or facial lesion. Fundus oculi as before.

First Dressing

Dressing changed without anæsthesia ; cavity dry ; no pus in cerebellum ;

Cerebellar Abscess, Acute, Otogenic

tube withdrawn, cerebellar cavity aspirated, no pus Tube re inserted and cavity plugged again (Plugs over the lateral sinus were left *in situ*)

To be left for 48 hours

NOTE —Only a cortical mastoid operation had been performed

30 12 42

Well, still slight nuchal rigidity, alert but yawns, temperature, pulse, respiration normal, colour good, no ataxy, no nystagmus, no facial, no facial palsy, fundus improving, dressing changed, cavity clean, tube to, but not through the dura, after use of suction and sinus forceps to prise open the dura incision the cavity was suddenly flooded with clear fluid (? cerebro spinal fluid)—a pocket of sinus fluid

Cavity aspirated, tube inserted, cavity packed, plugs in lateral sinuses still in

2 1 43

Dressing changed as above no secretions, no nuchal rigidity

Lumbar Puncture

Over 200 pressure

Papilloedema, no symptoms

Dressed by medical officer aspirated, tube re inserted

Lumbar Puncture

Pressure 250

Clear fluid

Still papilloedema, no other symptoms no nuchal rigidity

Culture from Pus of Abscess—Pneumococci

4 1 43

Well, temperature, pulse, respiration all normal Alert, no symptoms no nuchal rigidity Plugs removed from sigmoid sinuses Abscess cavity clean, aspirated, tubes re-inserted

(The three leading symptoms of

(1) nuchal rigidity,

(2) ataxy of the homolateral arm,

(3) dysdiadokokinesis,

have all disappeared by now)

It is necessary to keep the abscess cavity open, even though the cavity appear dry This is done by keeping granulations from forming by firmly plugging the mastoid cavity with BIPP

7 1 43

Well, alert, sits up, no nuchal rigidity, no nystagmus, no ataxy no dysdiadokokinesis, fundus improving

Dressing changed, cavity clean, cerebellar abscess cavity aspirated cavity packed with BIPP (dressing has been unchanged three days)

11 1 43

Well, dressing changed Cerebellar abscess cavity dry and clean, aspirated, tube inserted, collar tube, BIPP plug (The access to the dura aperture can only be made by BIPP plug)

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Summary of Dressings

Day.	Date.	
	27.12.42	Drainage.
1.	28.12.42	1st dressing: tube drainage, cavity aspirated.
3.	30.12.42	Dressing: tube re-inserted; cavity aspirated.
6.	2. 1.43	Dressing changed; aspirated.
8.	4. 1.43	Dressing changed; tube re-inserted.
11.	7. 1.43	Dressing changed.
15.	11. 1.43	Dressing changed; aspirated, tube re-inserted.

CASE II.—*Cerebellar abscess (right): presenting initially as case of otogenic meningitis, secondary to chronic suppurative otorrhœa, with an acute exacerbation, extra-dural (peri-sinus) abscess in the posterior cranial fossa: radical mastoid, with evacuation of peri-sinus abscess: penicillin 100,000 units three hourly for ten days: temporary recovery followed within two weeks by the clinical signs of a cerebellar abscess: immediate drainage through Trautmann's triangle: recovery.*

3.4.47

L.D., male, aged 15, admitted to St. Andrew's Hospital (L.C.C.) with headache. Temperature 104°. Rash mistaken for rubella.

Examined by me on day of admission; lies on back, alert, flushed, co-operative, gives history of right earache *for one day only*, and no cross-examination can elicit any longer history; the right ear has been discharging for two years.

Slightly tender over and in front of mastoid; no otorrhœa; but pulsation in depth of the ear; obscured by debris, simulating a commencing otitis. The patient has been under treatment ten years previously for bilateral otitis; hears well with this ear. Nuchal rigidity well marked. No other physical signs; bilateral flexor response.

Lumbar Puncture

Pressure 120 mm. water.

Queckenstedt's Positive on Right.

Fluid turbid.

Cells 1,750 per cu. mm.; 94 per cent. polymorphs; 6 per cent. endothelial.

Protein 140 mgr.

Globulin Heavy excess.

Chloride 640 mgr.

Sugar 57 mgr.

X-ray of Mastoids

Sclerotic process both sides. Sigmoid sinus line intact.

Operation, 3.4.47

Sclerotic process; when excavating the cavity (which bled freely) deeply and posteriorly a gush of pus escaped under pressure. With difficulty the deeply situated mastoid antrum was exposed and this was merely engorged as was the attic, the radical operation being performed; no cholesteatoma.

In view of the cerebrospinal fluid findings it was decided to deliberately expose the posterior cranial fossa. This was difficult; the bone was thick and markedly engorged. The hæmorrhage hampered the removal of the bone. Ultimately the sigmoid sinus was exposed with a large inodorous peri-sinus

Cerebellar Abscess, Acute, Otogenic

abscess and pachymeningitis externa over the sigmoid sinus, which was needled and blood withdrawn, a meatal plastic, BIPP plug over sinus and into cavity of middle ear

Penicillin 100,000 units given intramuscularly three hourly for ten days

NOTE—The danger of treating such a case with penicillin alone. The extra dural abscess pus would be overlooked and the patient would have succumbed

In view of the disease disclosed in the posterior cranial fossa, the possibility of extension to the cerebellar abscess always existed

The patient was daily examined for

- (1) Nuchal rigidity and if necessary lumbar puncture with pressure and cytological examinations
- (2) Nystagmus
- (3) Facial paresis
- (4) Past-pointing
- (5) Ataxy
- (6) Dysdiadokokinesis

14 4 47

The only regular daily pathological physical sign was nuchal rigidity cerebellar signs were absent. This prodromal period terminated rapidly and dramatically

At 4 p.m. the examination was negative, at 6 p.m. cerebellar signs were developing at a rapid rate,

Well, till to day

Sudden severe occipital headache—with vomiting. Temperature normal, pulse 50 to 60. Lies on back, face flushed. Alert, hears with affected ear, co-operative, not drowsy, but keeps eyes shut—photophobia. Nystagmus coarse now to left on looking left. Later (two hours later) coarse and spontaneous on looking forwards. Pupils wide—equal, fundus normal. Do not react to light. Only slight trace of nuchal rigidity. Arm jerks, equal plus plus plus. No loss of muscle tone, grips equal—firm joint sense, no sensory loss. Abdominal reflex equal brisk, knee jerks plus plus equal. Right flexor, left extensor response. Marked ataxy of right arm (finger to nose). Dysdiadokokinesis well marked.

Lumbar Puncture

Pressure about 100, turbid 1,000 cells, chiefly polymorph

14 4 47

Operation Intratracheal ether, ischaemic injection of flap. horizontal incision posteriorly. plugs removed. bone over sigmoid sinuses removed. Sinus exposed from above to below, packed BIPP (one small above and one long below). With use of bone forceps Trautmann triangle well exposed. dura palpated, firm, no abscess felt, sinus packed off, dura exposed at Trautmann's triangle incised with tenotomy knife, pus escaped, about two ounces aspirated, small tube through dura, large rubber drainage tube as collar, plugged BIPP around.

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18.4.47 (Day 5)

Dressed each day by passing rigid suction tube (No. 2 eustachian catheter) into abscess cavity—pus escaped, but none comes through tube. Dressing clear; collar tube *in situ*. Temperature normal; pulse normal. Alert; lies on left side; reading newspaper. *No nystagmus*. No headache. *No nuchal rigidity*. No past pointing, *but deliberately compensates with right finger at least two inches*. No ataxy. No discharge. Arm and leg jerks plus plus. Is sufficiently alert to do finger to nose test with eyes open, with eyes shut, dysdiadokokinesis automatically.

21.4.47 (Day 8)

Well; aspirated daily. Pus "around tube" inside collar.

25.4.47 (Day 20)

Tube out; well.

CASE III.—*Cerebellar abscess (right) with spontaneous recovery. (Has this patient in the ensuing four years during which she was observed, developed a chronic encysted abscess or cyst of the cerebellum?)*

This case is, in my experience, unique, as it was clinically diagnosed as a cerebellar abscess, yet the patient recovered with the operation being performed only for drainage of the mastoid. The diagnosis was established, or rather clinched by the onset of dysdiadokokinesis. I am unaware of the development of this physical sign in the absence of a cerebellar abscess, cerebellitis (cf. encephalitis) being too vague a diagnosis. The subsequent occasional attacks of headache, vomiting and vertigo—all resolving completely—might be due to the presence of a chronic encysted cerebellar abscess, but the repeated normal cytology of the cerebrospinal fluid rules this out.

Cerebellar abscess with meningitis: (without drainage of the abscess.) spontaneous recovery: with a note on the case four years later.

4.3.43

A girl (R.W.) aged 11, was admitted to St. Andrew's Hospital as a case of otogenic meningitis. There had been right earache, headaches, and otorrhœa for five days. The temperature on admission was 103°, the pulse 100. The patient is flushed; lies on her back; is alert and co-operative with a good memory. There is no aphasia; nuchal rigidity is well marked, with a positive Kernig; no facial paresis; no past pointing; no ataxy, no dysdiadokokinesis; no nystagmus; abdominal reflexes brisk; left knee jerks exaggerated plus plus; right absent. Bilateral flexor response. Fundal changes. She hears well with right ear, which has a scanty discharge with pulsation.

Lumbar puncture under tranquil anæsthesia

Pressure 300 mm. water: turbid.

1,200 cells; 56 per cent. polymorphs; 44 per cent. lymphocytes.

Chlorides 730.

5.3.43

Operation: Right cortical mastoid operation; pus in cells; the sinus and dura were not exposed.

Lumbar Puncture

414 cells per cm. mainly polymorph.

Cerebellar Abscess, Acute, Otogenic

On sulphathiazole, 6 grammes so far, 10 ccs blood injected intramuscularly

8 3 43

Well, temperature down

Lumbar Puncture

Pressure 180, 50 cells 70 per cent lymphocytes

Full Examination of Cerebrospinal Fluid

	5 3 43	16 3 43
Appearance	Clear	Clear
Cells	414	48 per c mm
Lymphocytes	14 per cent	70 per cent
Polymorphs	86 per cent	30 per cent
Red blood cells	few	60
Total Protein	30	45
Chlorides	740	750 mgr
Sugar	60	57 mgr
Culture	sterile	sterile
No organisms or T B seen		

18 3 43

Well, but now has bilateral papilloedema

For three days, frontal headache and vomiting, no giddiness, no wasting, temperature normal, pulse from normal to 60, respiration normal, lies curled up on *left* side, lethargic but otherwise not drowsy

Lumbar Puncture

Pressure 140 mm water—see change compared to above Curled on *left* side, alert, co operative, memory good responds promptly to questions

19 3 43

Lies curled up on *left* side, no nuchal rigidity nystagmus slow pendular on looking right and left, sustained, non-vertical Pupils wide, react to light Fundal changes, mild No facial, *some ataxy of right arm, some dysdiadokokineses*, no weakness Brisk equal abdominal reflexes Knee jerks equal, exaggerated, bilateral flexor response Right ear, debris in meatus

23 3 43

No headache, no vomiting, three days, lies on back temperature normal, pulse normal not slow, no nuchal rigidity Still slight ataxy right arm, slight dysdiadokokineses Nystagmus slow pendular sustained to right and left upwards No arm jerks, brisk abdominals knee jerks only Patellar reflexes, bilateral flexor response

White cells, 60,000

For further lumbar puncture

24 3 43

Pressure 300, cells no excess, protein 25, glucose 680 chloride 710

Well, temperature and pulse normal, no headache, no vomiting, no nuchal rigidity, no facial paralysis, nystagmus to right and left and looking right and left None vertical No ataxy no dysdiadokokineses, papilloedema plus plus

31.1.44

Admitted. Papilloedema on right. Nystagmus to right. Vertigo to-day. No past pointing. Suggest cerebellar lesion probably inflammatory.

2.2.44

Lumbar Puncture

Pressure 130 mm. water.

Cells no excess.

Fluid clear.

Queckenstedts test negative.

Total protein 20.

Globulin no excess.

Sugar 50 mm.

Chlorides 700 mgr.

4.2.44

Dizziness. Fine nystagmus to right and left. Recent symptoms considered of labyrinthine origin—no indication for encephalography (Mr. D. W. C. Northfield).

10.2.44

Better, no vertigo.

Blood Count

4,150,000 reds ; 67 per cent. Haemoglobin 0.81 Colour Index.

10,800 whites ; 60 per cent. polymorphs ; 35 per cent. lymphs.

May, 1947

This patient has grown into a fine strapping adult and has been seen regularly since 1943. She occasionally gets attacks of headaches with vertigo. In May, 1947, with such an attack, she was admitted, examined neurologically and a lumbar puncture performed. All proved negative.

25.3.47

Admitted on account of headache, vertigo.

Lumbar Puncture

Pressure 50 to 150 mm.

Rose to 200 on compressing either internal jugular vein.

Fluid clear.

Total protein 25 mgr.

Chlorides 720 mgr.

Sugar 66 mgr.

Nystagmus very fine when looking to right, coarse slower on looking to left.

October, 1947

Well ; occasional headaches ; vertigo.

1948

Re-admitted with petit mal. Discharged well.

CASE IV.—*Cerebellar abscess : delayed operation (case only observed by me at the Terminal stage) : drainage three months later : death.*

This case was transferred to my care only on the day of death and was not operated upon by me.

Chronic encysted cerebellar abscess : right : delayed operation : later drainage : death

Cerebellar Abscess, Acute, Otogenic

TABLE III

TABLES TO SHOW DURATION OF DRAINAGE IN SIX SUCCESSFUL CASES OF CEREBELLAR ABSCESS CASES A B C D ARE SUMMARIES OF CASES PUBLISHED IN THE *Journal of Laryngology* 1942

CASE I			
Day	1	27 12 42	Operation
	2	28 12 42	Tube changed cavity aspirated (collar left <i>in situ</i>)
	3	30 12 42	Tube changed cavity aspirated (collar left aspirated)
	5	2 1 43	Tube changed cavity aspirated (collar left aspirated)
	7	4 1 43	Tubes changed—aspirated
	10	7 1 43	Tubes changed—aspirated
	15	11 1 43	Tubes changed—aspirated
CASE II			
Day	1	14 4 47	Operation
	1-5	18 4 47	Dressed daily by passing Eustachian catheter No 2 into abscess cavity collar tube <i>in situ</i>
	8	21 4 47	Ditto daily
	20	2 5 47	Tube out well
CASE A			
Day	1	9 12 38	Aspiration of cavity
	2	10 12 38	Tube withdrawn
	3	11 12 38	Cavity aspirated (had propelled)
	6	14 12 38	Tube re inserted into abscess
	8	16 12 38	Tube still in
	11	19 12 38	Tube still in—manipulated
	12	20 12 38	No pus through tube
	15	24 12 38	Sinus forceps inserted some pus Silver wire drainage tube inserted
	17	26 12 38	No pus drained sinus forceps inserted pus escaped
	18	27 12 38	Tube in Pus escaped
	19	28 12 38	Small rubber catheter inserted
	22	31 12 38	Tube re inserted
	23	1 1 39	Tube still in not draining
	28	6 1 39	Tube still in
	32	10 1 39	
CASE B			
Day	1	1 6 40	Operation
	2	2 6 40	Tube changed cavity aspirated
	5	5 6 40	Cavity aspirated
	10	10 6 40	Tube changed aspirated
	15	15 6 40	Dressing unchanged for six days
	34	4 7 40	Healed
CASE C			
Day	1	9 8 40	Operation
	2	10 8 40	Aspiration
	4	12 8 40	Aspiration No pus tube still in
	11	19 8 40	Wound dry no pus from tube but sinus forceps inserted along side into cavity draining a large abscess in the neck had pocketed
	13	21 8 40	Pus aspirated tube full of pus
	15	23 8 40	Pus aspirated tube full of pus
	18	26 8 40	Slight amount of pus tube shortened re inserted
CASE D			
Day	1	3 3 41	Operation
	3	5 3 41	Aspirated no pus
	5	7 3 41	Pus aspirated away
	6	8 3 41	Aspiration
	8	10 3 41	Dressing unchanged
	10	12 3 41	Tube dislodged cavity aspirated no pus
	13	15 3 41	Dressing unchanged seven days dura fistula healing

Comment

This was a case (rare) of a *chronic encapsulated* cerebellar abscess; present for at least three months with a well-defined thick capsule—locateable by palpation, removable *in toto* by excision, before or preferably after extrusion, following a decompression.

The case should have been operated upon three months before.

Operation

The cerebellum was aspirated using a fine bore record needle; no pus was obtained. After the operation the patient ceased breathing, but (with oxygen perfused through an intratracheal catheter) the heart continued to beat for thirty minutes.

Autopsy revealed an encapsulated thick-walled cerebellar abscess which dropped out. It was superficial and contained thick pus, and had been present for over two months duration. The diagnosis was unmistakable:

- (1) Inflammation of the ear with meningitis.
- (2) Resolution of the meningitis.
- (3) Continuance, after an interval of intracranial signs (syndrome de discordance).
- (4) Characteristic cerebrospinal fluid changes 50 cells, mainly lymphocytes.
- (5) A raised pressure of over 200, which occurs *in the presence of papilloedema*.

TABLE OF CHANGES								
Cerebrospinal Fluid								
Day from onset	Date	Colour and Pressure	Cells	Total Protein	Globulin.	Sugar.	Chloride	Culture.
9	29 10 42	Turbid, 240	Not counted	300 mgr	nil	Good reduction		Sterile
10	30 10 42	Turbid	Pus plus pus	220 mgr	nil	Reduction		Sterile
11	31 10 42	Turbid		300 mgr	nil	"	710	"
15	4 11 42	Turbid	660 30% polys 70% lymphs	100 mgr	nil	"	720	few pos cocci
30	19 11 42	300	280 70% polys 70% lymphs	60 mgr	nil	"		
31	20 11 42	Red	13,200					
32	22 11 42	Turbid	3,216 chiefly polys	110 mgr.	nil	"		Sterile
35	24 11 42	130	30% mainly lymphs	50 mgr.	nil	"	700	Sterile
44	3 12 42	210				"	730	
54	13 12 42	140	4 lymphs	50 mgr	nil	"	720	Sterile
70	15 1 43	230	19 lymphs					
78	25 1 43	Fluid dropped out slowly	16 all lymphs					
82	29 1 43		16-10 lymphs	30 mgr	nil		700	
	6 2 43	300	6 polys	45 mgr			700	
	9 2 43		No cells					
	23 43	over 300	8 lymphs	25 mgr				
			No cells					(Bilateral Papilloedema)

Comment

This case came under my observation within a day of the termination. The case history and clinical findings leave no doubt that the cerebellar abscess was diagnosed with certainty at an early stage. In spite of this clear clinical picture, for reasons which the present writer is unable to fathom, no operation was undertaken until some three months had elapsed when it was too late and the case terminated fatally.

Cerebellar Abscess, Acute, Otogenic

I have no doubt that had early operation been undertaken, the ending might not have been so disastrous. The history of this case should be compared with the last one.

CASE V —[Not under my care but inserted to illustrate the cerebrospinal fluid changes and the result of temporizing.] *Cerebellar abscess (right) secondary to chronic suppurative otorrhoea with granulations, complicating a sinus thrombophlebitis, diagnosed early by the classical sequence, operation delayed, aspiration, death*

The turbulent pyrexial aspect of a predominant thrombophlebitis may obscure the presence or onset of a cerebellar abscess—but if the possibility of the latter is always borne in mind in every case where there is an extension of the infection to the posterior cranial fossa the diagnosis can invariably be made. This applies particularly to a case of sinus thrombophlebitis. It has well been said that the cases of overlooked cerebellar abscess are so numerous as to be a matter of comment.

In the following case, presenting as a case of pyrexia of obscure origin, the detection of the chronic ear discharge incriminated the sigmoid sinus as the source, but at first it was overlooked as was the onset of the cerebellar abscess.

Admission (Day 1)

Young adult male presented as a case of high fever of obscure origin, associated with a right chronic otorrhoea with cholesteatoma. A lumbar puncture on admission showed a pressure of 250 mm. water and about 400 cells per c mm. mainly polymorphs.

While in hospital, nuchal rigidity, ataxy of the right arm, dysidiadokokinesis and coarse spontaneous nystagmus to the right and to the left especially marked on looking to the right.

Day 5

Lumbar puncture now showed

Pressure 120 mm. water

Cells 18 20 per cent lymphs, 80 per cent polymorphs

Right radical mastoid operation, without exposure of the posterior or middle cranial fossa.

The case was observed further, some days later the patient became comatose. Referred to a neurological surgeon, a cerebellar abscess was tapped and penicillin injected with temporary relief, a few days later a cerebellar decompression was performed, but the patient died.

Comment

- (1) The sinus thrombophlebitis was overlooked as the cause of the pyrexia.
- (2) Operation was deferred too long.
- (3) The posterior fossa was not exposed.
- (4) Having detected cerebellar signs the cerebellum was not explored until too late.

The syndrome of discordance i.e. persisting nuchal rigidity with minimal change supervenes.

The low pressure of the cerebrospinal fluid relegated the abscess to the cerebellum.

In this case too, only little was done, and *that* too late ; early operation on the mastoid ; prompt exposure of the posterior cranial fossa ; early recognition of the cerebellar abscess with prompt drainage—such as through Trautmann's triangle, would give the patient an almost one hundred per cent. chance of survival.

The early diagnosis is easily made in the case from the classical sequence—viz.

- (1) Persisting nuchal rigidity.
- (2) Improvement in the cerebrospinal fluid, the cell count vendue less.
- (3) Minimal changes chiefly lymphocytes.
- (4) These changes not being reflected—the patient's clinical condition which remains stationary for a time but then deteriorates rapidly.
- (5) The relatively low cerebrospinal fluid pressure (120 mm. note).
- (6) The onset in due course of cerebellar signs, viz. ataxy of upper limb on same side and dysidiadokokinesis.

Additional case record to show that a *temporal lobe* abscess may develop when a cerebellar abscess might be expected.

Formation of a temporal lobe abscess though the active infection had spread from the mastoid to the posterior cranial fossa and had produced thrombophlebitis of the sigmoid sinus. Diagnosis of temporal lobe abscess easily made in view of the paralytic symptoms and aphasia operation and drainage through the squama. Recovery. A note on the aphasia.

Forster, H. V., records a similar case, 1938, *Proc. roy. Soc. Med.*, xxxi, 897.

CASE VI.—*Thrombophlebitis (obliterative with obturating thrombus) of the sigmoid sinus, with development of a brain abscess above the tentorium. clinical diagnosis of the temporo-sphenoidal lobe abscess : drainage by operation. recovery, with a note on the case five years later.*

This case illustrates a corollary to the general rule that if the extension of the infection is from the mastoid into the posterior cranial fossa, then, if a brain abscess develops it should arise in the cerebellum (Korner's law) ; if into the middle cranial fossa, in the temporo-sphenoidal lobe.

Here, though, the thrombophlebitis of the sigmoid sinus (in the posterior cranial fossa) was diagnosed and operated upon, the brain abscess which developed occurred in the *temporal lobe*. Hence the importance of a routine *repeated complete* neurological examination in all cases of intracranial otogenic complications, especially when the case presents clinically as one of meningitis. When this is coupled with repeated diagnostic lumbar punctures, a precise diagnosis can be made of the lesion present, and its location whether above or below the tentorium.

Temporal lobe abscess (left) characterized by predominantly paralytic symptoms, including motor and sensory aphasia ; operation, with tube drainage through the squama ; recovery.

Summary

Male age 8, with chronic suppurative otorrhœa (cholesteatoma) for which a cortical mastoid operation had been performed in the past ; admitted with a sub-periosteal mastoid abscess ; drainage and conversion into the radical

Cerebellar Abscess, Acute, Otogenic

mastoid Three weeks later onset of meningitis, operation of labyrinthotomy, thrombophlebitis of the sigmoid sinus Two months after the sub periosteal abscess, temporo sphenoidal lobe abscess with paralytic symptoms predominating, including a motor and sensory aphasia, drainage by tube, and suction through the squama, relapsing meningitis recovery, closure of the gap in the squama three years later by costal cartilage implant, patient well and normal five years after operation

20 4 42

The patient, a boy of 8, had, some years previously, a left cortical mastoid operation performed elsewhere for *chronic* otorrhœa, a note being made at the time that a radical operation would be necessary He now presented with an acute exacerbation of the chronic otorrhœa, which had persisted There was recent earache and a swelling over the mastoid—a sub periosteal mastoid abscess with cholesteatoma This was drained by the house surgeon, the cortical mastoid cavity being converted into the radical The dura of the middle and posterior cranial fossa was exposed

Post-operative progress for the following three weeks was uneventful, except for a slight rise in temperature The incision healed up, the mastoid cavity was clean The child now complained of headache, and vomiting with a temperature of 103°, without a rigor

The child's face was flushed, he remained alert, and co operative Nuchal rigidity was well marked, all reflexes sluggish, the abdominals being completely absent, bilateral flexor response Fundus oculi normal

Lumbar puncture, 8 5 42

Pressure 200 mm water

Fluid turbid

Cells 7,048 whites per cm, 95 per cent polymorphs 5 per cent lymphocytes (also 44 red cells)

Chlorides 680 mgr per 100 c c

Culture, slight growth of non hæmolytic streptococcus

10 5 42, *Operation*

The mastoid cavity was re opened, the dura of the middle and posterior cranial fossae exposed, without disclosing any extra dural abscess The sigmoid sinus was patent, dura under tension no cerebrospinal fluid escaped through the exploratory punctures through the dura of the middle fossa anterior and posterior labyrinthotomy, cavity plugged

Treated by sulphapyridine and 10 c c of whole blood injection

12 5 42

Better, nuchal rigidity facial paralysis

12 6 42, *Lumbar Puncture*

Clear, colourless fluid

White cell count, 5 5 cells per c mm

There were also 117 red blood cells per cm This would account for the very slightly raised white cell count

Chlorides, 700 mgr per 100 c c

Protein, 50 mgr per 100 c c

21 6 42

The child remains well, alert and co operative with symptoms or physical

N. Asherson

signs other than irregular swinging temperature (up to 104°) ; no rigors ; some slight tenderness in the upper part of the neck on the left. Chest normal clinically and radiologically ; no metastases ; was busy ; facial paralysis unchanged.

Blood culture negative. White cell count 5,600 per c.mm.

Comment

The persisting (and otherwise symptomless) pyrexia suggested a thrombo-embolophlebitis of the sigmoid sinus. A lumbar puncture drew off normal cerebrospinal fluid. Queckenstedt's test showing the sigmoid sinus to be patent on the left.

21.6.42, Operation

The sigmoid sinus was exposed ; the lateral sinus adjacent to the genu was needled and blood withdrawn. Needling of the sigmoid sinus proved negative. The sinus was packed off above and then incised, a clot being removed. A probe inserted to the bulb produced but a little oozing. The sinus wall was blackened. The cavity was firmly plugged with BIPP gauze.

24.6.42

Temperature still rising up to 104° . No other symptoms ; blood culture negative ; blood count 3,700,000 reds. Transfusion of half-a-pint of blood.

11.7.42

Red count 4,400,000 per c.mm.

14.7.42

There has been frontal headache for ten days with exquisite tenderness over the left frontal sinus ; vomiting of the past three days.

He lies curled up on the right (sound) side, face flushed, is apathetic and drowsy with *complete aphasia* for the past twenty-four hours. He cannot utter words, nor does he recognize the name or the use of common articles. *He has not moved the right arm* for the past twenty-four hours. About five days ago he noticed that he could not hold a pen between his fingers. He cannot grip with this hand.

There is no nystagmus ; *papillædema of the left fundus* ; *nuchal rigidity well marked* ; flaccid paralysis of the right arm, arm jerks absent ; *right abdominals absent* ; left normal ; no knee jerks ; bilateral flexor response.

Lumbar Puncture

Pressure 250 mm. water.

Fluid clear.

150 cells per c.mm. ; 80 per cent. polymorphs.

Protein 140 mgr.

Chlorides 715 mgr.

14.7.42, Operation

Squama resected ; dura tense ; no herniation ; stab punctures of exposed dura ; no escape of cerebrospinal fluid from upper punctures, slight from the lower.

The temporal lobe was exposed forwards one inch in front of the meatus and at a depth of two inches a huge abscess was evacuated. The dura was incised ; rubber drainage tube inserted and sutured to the dura ; cavity packed with BIPP.

Cerebellar Abscess, Acute, Otogenic

Commentary

The diagnosis of the temporal lobe abscess was obvious. A cerebellar abscess might have been expected in view of

(1) Long period of ill health with no localizing or indeed any intracranial symptoms

(2) The presence of sigmoid sinus thrombosis, ensuing on labyrinthitis

The localization of the abscess in the temporal lobe was established by the following points

(a) Unilateral frontal headache with tenderness

(b) Nuchal rigidity, with slight cerebrospinal fluid changes—note the syndrome de discordance, cf cerebrospinal fluid on 21.5.42 and 12.6.42

(c) Paralysis of opposite arm only and unilateral absence of the abdominal reflexes

(d) Unilateral papilloedema

(e) Complete aphasia

(f) Absence of cerebellar signs

(g) A cerebrospinal pressure of over 250 mm water

NOTE—The intense left frontal headaches with tenderness over the frontal sinus and vomiting are common to a temporal lobe or cerebellar abscess—i.e. an infra or supra-tentorial lesion

The monoplegia was first noticed by his inability to hold a pencil between his fingers, later the wrist was paralysed and finally the entire arm was involved. This right brachial monoplegia of gradual onset (some four days) with a complete motor and secondary aphasia for twenty-four hours, papilloedema relegates the lesion to the left temporal lobe, adjacent to Broca's convolution. The escape of the right face and the fact that there was no right facial paralysis indicates that the abscess is deeply seated and not subcortical.

The pressure of the cerebrospinal fluid of 250 mm water relegates the lesion supra-tentorially (Asherson, 1942)

14.7.42

Pus from cerebral abscess

Direct film, fairly numerous Gram positive cocci arranged in ones, twos and short chains

Culture, pure growth of a hæmolytic streptococcus

15.7.42

Better, awake, aphasic, says 'Yes' and 'No' only. Has asked for drink. Physical signs unchanged. Papilloedema right side

16.7.42

Trismus on account of pain. Cries when being moved to theatre. Can say 'I want a drink', confused re his mother, says 'Yes' and 'No' nods head or shakes, arm still paralysed

Bilateral papilloedema more marked on the left. Right abdominal reflexes absent, bilateral flexor response. Dressing changed, small amount of pus aspirated

17.7.42

Well to date, temperature 100°, pulse 110. Suddenly went unconscious at midnight with twitching of the right face

The operation field was exposed and the drainage tube manipulated, pus

escaping in some definite quantity; aspiration removed more, the cavity being completely emptied.

18.7.42

Well but still aphasic; can nod head or say "No" by mouth as well as moving head from side to side; can raise head; right hand can be moved though still weakness; can hold pencil. Says "No" to every question; cannot name article or indicate its use, but if asked to unbutton his pyjama coat, does so promptly without any slow cerebration; told to put a penny in his pocket (of his pyjama coat) he promptly takes the coin and puts it in his "left trouser" pocket (which, of course is not there); uses his left hand to do all spontaneous actions.

No right facial weakness; abdominal reflexes absent on both sides. No nuchal rigidity; bilateral flexor response; right fundus reverting to normal; left still marked papilloedema.

Is alert, bright and co-operative as far as he can do.

19.7.42

Well; speechless; cannot write but understands what is said. Moves right arm; no nuchal rigidity; abdominal reflexes absent still on right.

Dressing changed. On removing tube a large amount of pus welled up and was aspirated away, the aperture being kept agape by spring dressing angled forceps. Tube re-inserted. No hernia cerebri. No more headaches or tenderness over the left frontal sinus.

Comment

He cannot write, read or speak except to say "Yes" or "No", but he has once asked for a drink. Does not recognize articles. When handed book picture upside down soon turns it up the right way. No obvious slow cerebration. When I took the book away, he yelled. Abdominal reflexes now present. Cavity clear; nil aspirated.

22.7.42

Well; no vomiting. He was vomiting for the previous twenty-four hours, when the dressing was changed and the tube withdrawn, chocolate coloured pus gushed out; aspiration removed more pus and a slough of brain tissue sent for section. Manipulation of a long sinus forceps inserted into the cavity results in pus welling up from the depths.

Understands; still aphasia but can now write simple things such as his name and A B C when asked to do so; no slow cerebration. Moves right arm, but dysdiadokokinesis (due to weakness).

No abdominal reflexes on right. Fundus as before.

Dressing left unchanged.

On sulphonamide EOS for three days; 12 grammes approximately to prevent vomiting. Was blue at times.

23.7.42

Well; begins to say occasional words. When asked his name says "Eddie"; understands; can say "Badge on nurse", but cannot repeat it; cries. Smiles. Recognizes. Sits up.

Pulse and temperature normal; wound dressed; slight amount of pus; aspirated. Brain had oozed through hole in drainage tube.



CASE 6

After drainage of the temporal lobe abscess. Note facial lesion
10 days after drainage and 4 days prior to 2nd attack of meningitis



CASE 6

Hernia cerebri 1 month after drainage of Temporal lobe abscess

Cerebellar Abscess, Acute, Otogenic

25 7 42

Well, temperature normal, says some words—"Can I go home?" speech slurred—no right facial paralysis, can point out colours Difficulty with blue Says "No, don't think so" Dressing changed, cavity clean

27 7 42

Temperature and pulse normal

Has developed a *ravenous appetite* *Beginning to speak* and asks, "When is Mr Asherson coming?" Can name many common articles now, not all, but understands promptly what is said, if he cannot remember the name he will identify it from a number of names spoken to him, realizes he is at a loss for the correct word—will repeat answer subsequently (perseverance)—e g he cannot name an egg, but can identify it—when told it is an egg will repeat correct word—two questions later he will say "an egg"—can write now He now has a true amnesic aphasia

Tube unchanged now for three days—worked clear—no pus, the tube had slipped out

28 7 42

Tube changed Has vomited and is drowsy Speaks without slur "When can he go home?" Reads alphabet, A Cannot read other letters, or recognize "A" in the middle, repeats what is said Cannot read at all

Shown letter from grandmother, but cannot read it or say who it is from, yet he takes another letter and points to the words 'Dear Grandma', indicating that the letter is from her

Cannot name colours, mixes them, but when told the correct colour, agrees, recognizes when the incorrect colour is named Right arm grips well, keeps well, slight temperature last night On sulphonamide

31 7 42

Wound clean, tube shortened, no pus in sinus into brain Temperature and pulse normal Asks to get up Alert Aphasia—still partial, has word blindness and still perseveration, no slow cerebration

Cannot read, cannot repeat alphabet called out to him and repeats A, B, and then A again, can only recognize a few letters and the others he is aphasic or says A (this letter he knows), but is aware from the shaking of his head that he is not right and if one calls out the correct letter nods his agreement

When asked my name, he cannot say, but turns round to point to my name in large letters over his bed, tries to read it but can only do the first syllable Is getting up

It is now two and a half weeks since his operation for drainage of the temporal lobe abscess

Purdon Martin, in a personal conversation, says the word blindness (or visual aphasia) may be due to a localized area of thrombophlebitis spreading to there from the great vein of Labbe The prognosis is good

31 7 42, *Pathological Report*

Tissue from abscess cavity—small piece of granulation tissue with large numbers of organisms The organisms present are of two kinds—a Gram-positive coccus growing in short chains, probably a streptococcus, and a Gram-positive coccus growing in clumps, morphologically a staphylococcus

N. Asherson

2.8.42

Drowsy, but responds quickly; no slow cerebation. Still amnesic aphasia. No word blindness. Nausea; vomited once. Left supra-orbital headache and tenderness. *Tube had slipped out.* Sinus closed. Tube re-inserted; no pus; aspirated. Temperature and pulse normal.

3.8.42

Well; dressing tube changed.

4.8.42

Well; dressing tube changed; can still only say A, B, C, no further.

13.8.42

Has had three lumbar punctures; two whole blood injections; 25 grams of EOS.

Temperature normal; small amount of pus oozing from short tube in sinus; remainder of wound healing.

15.8.42

Well; cavity aspirated.

19.1.43

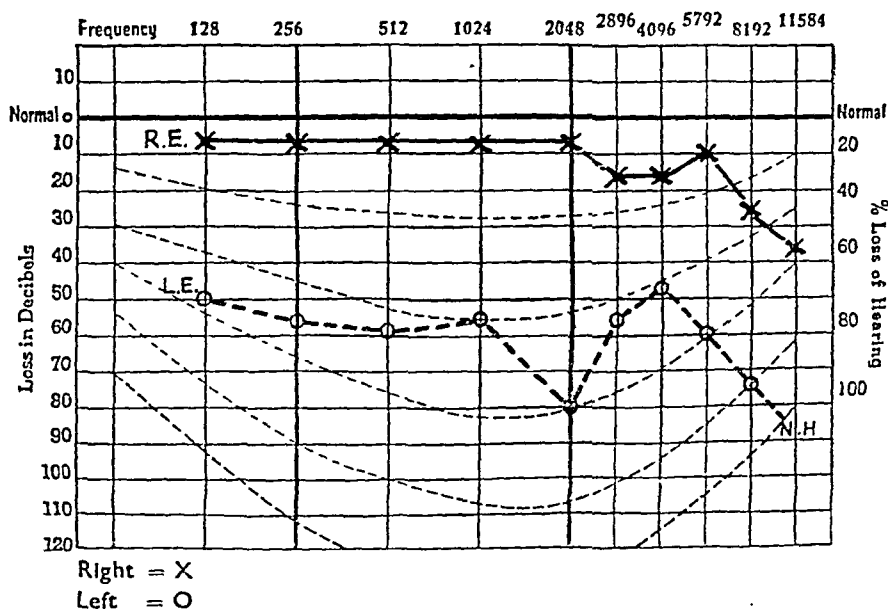
Deaf in left ear.

Neurological examination (Purdon Martin) negative.

June, 1947

The patient has been under observation for the past five years. He remains well and is working. The gap in the squama showed little evidence of closure after three years. In 1944, Mr. D. W. C. Northfield performed an operation, closing the gap with a costal cartilage graft, which took successfully. The radical mastoid cavity discharges from time to time.

The boy has grown into a fine tall, healthy strapping lad, without any residual symptoms referable to the temporal lobe abscess.



E.D. Audiograph taken 19th June, 1943

Cerebellar Abscess, Acute, Otogenic

Summary of Treatment

Day. Date.

- | | | |
|-----|---------|---|
| 1. | 14.7.42 | Drainage of temporal lobe abscess. |
| 3. | 16.7.42 | Dressing changed—cavity aspirated. |
| 4. | 17.7.42 | Drainage tube manipulated—cavity aspirated. |
| 6. | 19.7.42 | Dressing changed ; tube changed and re-inserted after aspiration of cavity. |
| 9. | 22.7.42 | Cavity aspirated. |
| 10. | 23.7.42 | Cavity aspirated. |
| 12. | 25.7.42 | Dressing changed. |
| 14. | 27.7.42 | Tube unchanged now three days ; changed. |
| 15. | 28.7.42 | Tube changed. |
| 18. | 31.7.42 | Tube shortened ; no pus aspirated. |
| 20. | 2.8.42 | Tube had slipped out ; sinus closed. Tube re-inserted ; no pus aspirated. |
| 21. | 3.8.42 | Tube changed. |
| 22. | 4.8.42 | Tube changed. |
| 31. | 13.8.42 | Tube shortened. |
| 33. | 15.8.42 | Small tube in. |
| 35. | 17.8.42 | Dressing unchanged ; small tube in. |

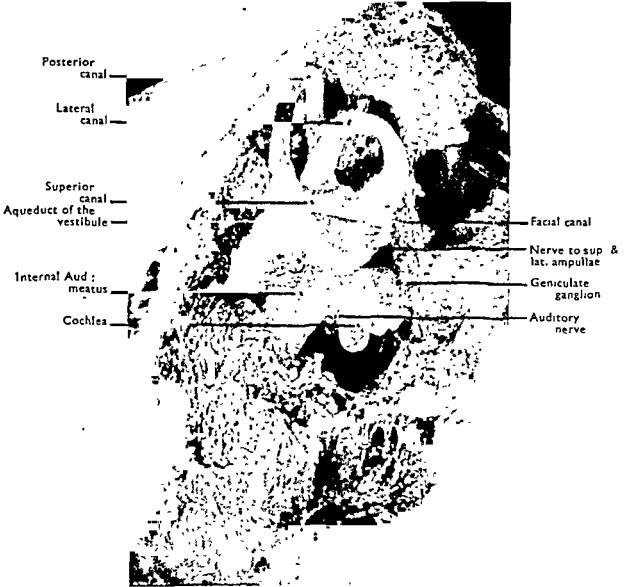
A NEW METHOD OF DEMONSTRATING THE LABYRINTH, TOGETHER WITH THOSE RELATED STRUCTURES WHICH LIE WITHIN THE PETROUS PORTION OF THE TEMPORAL BONE

By OLIVER GRAY (Haslemere)

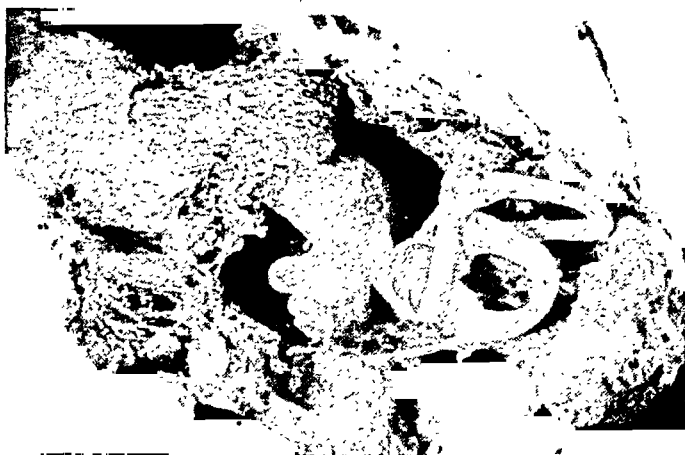
MONOMERIC methyl methacrylate is a liquid almost as fluid as water which, when heated or subjected to ultra-violet light becomes polymerized into a solid. This is known as the "polymer" and is as clear as glass.

The petrous portion of the temporal bone, containing the labyrinth, is removed. It is then thoroughly washed in running water and placed in 70 per cent. alcohol for twenty-four hours. Complete dehydration is now carried out by passing it through absolute alcohol. This takes about a fortnight. The alcohol must be changed on three occasions to free the specimen of all traces of water. It is next placed in methyl methacrylate liquid "the monomer" and, after two days, again transferred to a bottle of fresh monomer. This is done in order to eliminate the alcohol. Finally it is placed in a suitable glass bottle (which has previously been cleaned and dried) containing the monomer to which has been added 0.5 per cent. benzoyl peroxide. This is the activator which initiates the chain reaction converting the monomer into a solid, the "polymer". The whole is now allowed to rest in a bath of liquid paraffin and is submitted to gentle heat in a simple thermostatic container. Owing to the chain reaction during polymerization, heat is generated and bubbles are apt to form. The liquid paraffin helps to disperse the heat and lessens the tendency to bubble formation. If kept at a temperature of about 90° F. polymerization takes place in about six weeks, without bubbles. This period can be shortened by raising the temperature to about 120-130° F., and, as soon as there are signs of thickening of the fluid, the temperature is lowered; but the higher the temperature the greater is the need for frequent observations. Eventually hardening takes place throughout. The bottle is then taken and broken with a hammer and the clear block removed. This is next cut with a narrow tenon saw in any direction desired, and the cut section polished with different grades of glass paper, followed by wet pumice powder, and finally rendered as smooth as glass with wet whiting powder. The cochlea and semi-circular canals can now be made out in undisturbed relationship to one another and to structures inside and outside the bone.

A NEW METHOD OF DEMONSTRATING THE LABYRINTH, TOGETHER WITH THOSE RELATED STRUCTURES WHICH LIE WITHIN THE PETROUS PORTION OF THE TEMPORAL BONE—OLIVER GRAY.



Photographs of the human labyrinth in polymerized methyl methacrylate, after removal of the dense bone by Hydrochloric acid.



Photographs of the human labyrinth in polymerized methyl methacrylate after removal of the dense bone by Hydrochloric acid.

New Method of Demonstrating Labyrinth

More interesting results can be obtained by subsequent treatment with strong acid, for the polymer is resistant to this ; indeed it is completely unaffected by pure HCl.

It should be remembered that the petrous bone is extremely dense. Little of the acrylate finds its way therein. The labyrinth, nerves and blood-vessels, thus protected by the polymer, remain unaffected by the acid. Fifty per cent. HCl is used and, after a week or two, the pulpy bone can be separated away from these structures, leaving them perfectly intact.

The most spectacular results, however, can be achieved by arresting the polymerization at the "syrup" stage. The bone is then removed and the polymerization allowed to become complete. The specimen, now like a crystallized fruit, can be scraped (to remove the thin layer of acrylate) and placed in the acid bath. As soon as the acid has taken effect, some patient dissection will lay bare the whole of the labyrinth ; in addition the facial canal, the geniculate ganglion, the little nerves to the ampullae, the aqueduct of the cochlea (perilymph), the aqueduct of the vestibule (endolymph) and many other features can be seen clearly with the aid of a hand lens.

It should be pointed out that the process described, although quite original, is an adaptation of that so ingeniously devised by the late Dr. A. A. Gray of Glasgow,* in which paraffin wax was the medium employed. Nothing could vie with the results which he obtained in this way ; their chief drawback lies in the fact that they are extremely delicate and fragile and in addition require to be suspended in xylol. The results obtained by the new method have a different and complementary value. They are durable and permanent, and can be handled easily without fear of breakage and thus serve excellently as demonstration specimens. In addition the structures they reveal are so stubbornly fixed by the supporting medium that they cannot be displaced or distorted during dissection. This is of great advantage, since it overcomes one of the chief difficulties met with in attempting to display structures accurately in three dimensions. Take, for instance, the course of the facial nerve so incorrectly described in many books on the subject as lying in close apposition to the vestibule ; by means of this method its true course can be made out with the utmost clarity, in fact only in one situation does it lie in immediate proximity to the labyrinth, namely as it passes backwards beneath the lateral semicircular canal.

In conclusion, it is hoped that the method may have its application in other spheres, and that it may in the meantime commend itself to those who study the anatomy of the ear.

My thanks are due to Mr. J. C. Witcher for his help with the photographs.

* Vide "The labyrinth of Animals" and "The Atlas of Otology" by A. A. Gray, M.D.

CLINICAL RECORDS

CASE OF OSTEOMYELITIS OF FRONTAL BONE FOLLOWING ACUTE FRONTAL SINUSITIS, TREATED BY SURGERY AND PENICILLIN

By GILROY GLASS (Nottingham)

OSTEOMYELITIS of the Frontal Bone is perhaps the most dreaded complication of acute frontal sinusitis. It is too early to estimate to what extent the incidence and gravity of this complication will be reduced by penicillin, but it is fair to assume that its terrors and disappointments will be largely reduced. Watson (1) has recently described a case which recovered without surgical intervention, but even the most optimistic would scarce dare to hope that surgery will ever be replaced entirely.

At a time when increasing knowledge of chemotherapy and penicillin is altering the approach to the problems of surgery, the case record of a patient who would undoubtedly have died before the penicillin era but recovered with its use may be of value.

Donald K., aged 14, was referred to Nottingham General Hospital by Dr. Ritchie of Long Eaton on 14.1.47. He had a history of intense and increasing headache of fourteen days' duration. In the early stages it had been left-sided and had typical Sluder periodicity, but later had spread to both sides and become continuous. Œdema of the left upper eyelid commenced three days before admission and had increased rapidly.

On examination the patient was a well developed adolescent in good general condition. The left side of the nose was full of pus, the amount so great that it was impossible to ascertain with any certainty its source. The left upper eyelid was cedematous, almost closing the eye. The eye ball itself was displaced downwards, but movements, though restricted, were present and vision was unaffected. Temperature was 101°, pulse 100. Radiologically all the sinuses on the left side were opaque, the opposite side was clear. Previous history was negative.

The general condition being good, it was decided to postpone operation till the following day, and meantime to commence penicillin and sulpha-therapy to reduce the risk of complications. To this end an initial dose of 100,000 units of penicillin and sulphathiazole gm.ii was given, with a continuation dose of penicillin 30,000 three-hourly and sulphathiazole four-hourly.

15.1.47. Operation under general anæsthesia. Incision along the inner half of the orbital margin, curving medially and downwards over the nasal process.

A large sub-periosteal abscess of the roof of the orbit was found, but no communication with the frontal sinus could be detected. The sinus was opened through the medial lower angle, and pus under considerable pressure welled up into the wound. Drainage was established by means of three tubes:—through the fronto-nasal duct into the nose, through the external incision into the sinus

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and a third tube into the peri orbital abscess. At the same operation an intranasal antrostomy was performed, the pus in the antrum being under pressure.

Following the operation the penicillin dosage was reduced to 15,000 units every three hours.

22 I 47 Temperature normal. Œdema of eyelid subsiding. Wound clean. Tube removed from orbital abscess.

23 I 47 Temperature 101° at 6 p.m. Wound clean. No increase of œdema. General condition improved.

25 I 47 After a restful night woke at 6 a.m. complaining of headache. Five minutes later the nurse heard him "gurgling" and on going to his side found him unconscious with his right arm held stiff and flexed at the elbow, and his face twitching. This continued for some ten minutes, after which he relaxed for a short period. A generalized clonic seizure followed without incontinence, and lasted forty-five minutes, passing off as suddenly as it had commenced. He was unconscious throughout the convulsion, but regained consciousness immediately afterwards, complained of headache and vomited. He had no apparent knowledge of the attack.

When seen by a physician, Dr. Whimster, three hours later, he was quite rational and his neurological examination was negative.

Locally appearances had changed. There was marked œdema spreading up over the left forehead, with generalized tenderness, most marked at a point over the upper margin of the frontal sinus. There was no radiological evidence of osteomyelitis, as might be expected so early in the condition. A diagnosis of osteomyelitis, and extra-dural abscess was made. As the spread had occurred while the patient was receiving penicillin, it seemed unlikely that it would be controlled by penicillin alone and further operative measures were considered advisable.

Operation

The incision was extended to the mid-line and a vertical incision made in the mid-line over the forehead. When the flap was raised a sub periosteal abscess was found over the upper medial angle of the sinus, with pus oozing through the bone. The anterior wall of the sinus was removed and pus was then found tracking through the inner wall in the corresponding area. Followed up, this led to a large extra-dural abscess. The infected bone was nibbled away till normal dura mater was found and the wound was packed with gauze soaked in saline. Penicillin was increased to 45,000 units three hourly with an additional dose of 100,000 units once daily. Sulphathiazole in full doses was also given.

29 I 47 Condition has deteriorated gradually. Two brief attacks of facial twitching with loss of consciousness but otherwise no neurological signs. Cerebrospinal fluid pressure 200 mm. clear to naked eye. Cells 35 polymorphs, other constituents normal. On this date the deterioration became much more rapid, mentally he became drowsy, irritable and irrational, pulse rate increased and volume became weaker. The picture was ominous.

Operation

The wound was dressed under gas and oxygen anæsthesia. The osteomyelitis was seen to be spreading, and as a last resort it was decided to attempt

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to limit the spread by cutting a gutter in the bone. Accordingly the incisions were extended to give greater access and a horse-shoe shaped gutter was cut down to the dura half-an-inch beyond the visible edge of the osteomyelitis. A layer of gauze was placed in the gutter and two long perforated tubes placed thereon, with the object of flushing with penicillin. The wound and flap were covered with tulle-gras and a gauze dressing applied. At the conclusion of the operation two pints of blood were given. Penicillin was continued at the same level, and penicillin solution injected through the tubes every two hours.

30.1.47. Rational and mentally clearer, though petulant. The most striking thing was an ill-defined improvement so marked as to lead the nursing staff to declare against all evidence, that he would recover. He certainly appeared less toxic.

31.1.47. After a restful night woke with flaccid paralysis of the right arm and leg and loss of reflexes. The face was not affected. Cerebration slow, but rational. By evening the right arm and leg had become spastic, the deep reflexes were increased, and ankle clonus was present.

1.2.47. General condition improved. Speech slow but distinct. Some voluntary movement of extensors and flexors of wrist and fingers. Leg unchanged.

2.2.47. Free voluntary movement of all muscles of upper extremity. Leg still spastic.

3.2.47. Had two minor fits lasting about five minutes during night. Neither observed by the medical staff. In the course of the morning he had another fit which was observed by the writer. He commenced by calling out "nurse" but could not say why he had done so. A few seconds later he commenced a generalized clonic convulsion, with the movements more marked on the left side than the right; indeed the movements of the right arm were almost confined to the shoulder muscles. During the convulsion the right arm and leg were spastic. After about two minutes the clonic movements increased on the left side and gradually decreased on the right while the right arm and leg became flaccid. The facial muscles were little affected until the final stages when the left side of the face was twitching violently while the remainder of the body was flaccid.

Dr. Whimster saw him shortly after this seizure and reported the condition as Jacksonian epilepsy arising from vascular thrombosis in the motor area. Luminal was prescribed to control the fits and the continuation of penicillin advised. Sulphathiazole was now stopped.

Later the same day a complaint of pain directed attention to the right hip joint. The orthopaedic surgeon, Mr. Crooks, diagnosed an empyema of the joint and placed the thigh on extension.

5.2.47. The fits have continued three or four daily but of short duration and of lessening intensity. Voluntary movements of the foot present. Wound dressed and the osteomyelitic process was seen to have extended almost to the edge of the gutter in all areas, in some up to the actual edge.

7.2.47. Improved sufficiently to read, could dorsiflex the foot. Epileptiform seizures less frequent.

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10 2 47 For the first time has had twenty four hours free from fits
Granulations forming round the edges of the osteomyelitic bone

16 2 47 General condition markedly improved Now spends his time drawing
with the recently paralysed arm, and with considerable ability !

19 2 47 After consultation with the orthopedic surgeon it was decided to
attempt to remove the sequestered bone The outer table was removed, and
it was found that the bone of the inner table bled and might therefore be
considered viable A tulle gras dressing was applied and the wound left open

21 2 47 Movement of leg now completely returned and free from pain
Extension removed Penicillin dosage reduced to 15 000 units three hourly

24 2 47 Frontal bone covered with healthy granulations Flap drawn over
and sutured lightly in position

27 2 47 Penicillin stopped

4 3 47 Wound healed

9 3 47 Temperature 101 8° Slight cervical adenitis

14 3 47 Temperature 104 4° Generalized glandular enlargement including
neck axilla and groin Penicillin 45 000 units three hourly re commenced

15 3 47 Erysipelas of facial wound

20 3 47 All subsided again

31 3 47 General condition excellent Discharged from hospital

Patient was last seen towards the end of January, 1948 He is in perfect
health Luminal is still being taken as a precaution, but there has been no
evidence of any residual disability and his school record is testimony of his
mental ability

Commentary

Penicillin undoubtedly saved this patient's life On the other hand
complications appeared and spread in spite of the penicillin and without
adequate surgical drainage it seems unlikely that he could have been saved
The effect of penicillin was demonstrated most clearly in the recovery of the
bone after the osteomyelitis Instead of the whole affected bone being cast
off as a sequestrum, only the outer table had to be removed The line of
cleavage between the dead and the viable bone was distinct and separation easy
despite the short duration of the infection

The sequence of neurological symptoms throughout the illness can, in
Dr Whimster's opinion only be explained by a localized cerebral thrombosis
which recovered

In presenting the case the writer would like to express his thanks to his
colleagues who co-operated closely throughout in particular Mr Crooks
Dr Whimster and Mr McLeod, and to Sister Miss Hardy and the Nursing Staff
to whom the patient owed so much

PRIMARY CARCINOMA OF THE EUSTACHIAN TUBE

By E. R. GARNETT PASSE (London)

W.W., Male aged 55, was referred to the Ear, Nose and Throat Department in *March, 1946*, complaining of deafness in his left ear of gradual onset, and an eight weeks history of a painless swelling on the left side of his neck.

On examination the throat, nasopharynx, tongue and ear presented no apparent abnormality apart from a deviation of the septum to the left. In the neck there was a hard fixed gland palpable on the left side in the upper deep cervical chain.

He attended for a further series of monthly examinations until *June, 1946*, during which time no further symptoms other than increasing deafness developed. In August he again attended, complaining of a fullness of the left ear accompanying the deafness, and an eight weeks history of hoarseness of his voice. Examination showed slight increase in the size of the cervical gland, and evident thickening of the left drum, but no other abnormality. Bone conduction on this side was relatively increased and air conduction diminished. An X-ray of his sinuses revealed no abnormality.

In *November, 1946*, excision of the cervical gland was performed at which a gland one inch in diameter was located deep to the sternomastoid, firm in consistency and fixed to the surrounding tissues.

The pathologist's report was :—"Lymphatic gland infiltrated with polygonal celled carcinoma."

In *January, 1947*, posterior rhinoscopy revealed a mulberry-like tumour protruding from the mouth of the eustachian tube on the left side. An examination of his post-nasal space under anæsthesia was performed, at which a granular ulcer was discovered extending from the left eustachian tube and the left pharyngeal wall behind it. Biopsy :—"Squamous celled carcinoma of nasopharyngeal mucosa."

February 7th, 1947. Operation. Direct approach to the lesion was obtained by splitting the soft palate and removing the hard palate sufficiently forward to enable adequate direct approach to the growth to be obtained.

I then excised the growth with a diathermy knife—including the eustachian cartilage as far back as the growth extended—about half-an-inch. Then with a button I diathermied the whole area. The tumour extended backwards from the mouth of the tube as far as the Fossa of Rosemüller. 6×2 milligram needles of radium were inserted into the nasopharynx in a Stent mould and removed 92 hours later.

The palate healed by first intention and deep ray therapy was given to the left side of the neck.

March 25th, 1947, the patient was discharged from hospital.

November 4th, 1947. Sound union of palate—left side of post-nasal fossa clear of growth and lined by healthy scar tissue. The patient stated that three

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weeks after the operation his hearing began to return and now has returned completely

The case is of particular interest to otologists because of (1) its comparative rarity, (2) deafness as a presenting symptom and which cleared up on removal of the tumour, (3) the apparent slow growth of the tumour, and (4) the absence of any local signs of recurrence nine months afterwards

Schumaker, reports a complete cure in a man of 60 who complained of a six weeks history of fullness with accompanying deafness in his left ear, the hearing of which had been impaired for a number of years. The tympanic membrane appeared to have a yellowish tinge. The nasopharynx presented no abnormality and catheterization was accomplished. Obstruction of the tube *gradually occurred, and three weeks later a tumour observed in the mouth of* the eustachian tube, biopsy revealing a Grade IV Squamous Epithelioma. Therapy consisted of a 2 x 1 millicurie radon seed implanted 7-8 mm into the tumour, and three weekly doses of 300 r to the neck though no glands were ever palpable

Sixty-five days after treatment the patient's hearing was better than he had experienced for a number of years. His nasopharynx remained normal till his death from coronary accident three years after treatment. At autopsy no microscopic or macroscopic evidence of tumour was discovered in the region of the eustachian tube

Lawson in his review of the literature gives details of symptoms, signs, diagnosis and treatment, but few details of results. He reports one case of his own in a man of 59 treated with 10,000 r and six 2-millicurie radon seeds. The pathology of the tumour was a transitional celled carcinoma and the patient was alive, though no details were published

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SOCIETIES' PROCEEDINGS

ROYAL SOCIETY OF MEDICINE—SECTION OF OTOLGY

February 7th, 1947

President—H. V. FORSTER, M.C., M.B., Ch.B., M.Sc.

Transmeatal Attico-Antrotomy in Chronic Tympano-Mastoid Suppuration

By A. TUMARKIN, F.R.C.S.(Edin.)

Introduction.—Ten years ago I became convinced that radical mastoidectomy could not give me the results I wanted. Seeing a reference to the work of Thies on the transmeatal route (Thies, 1912; Trampnau, 1935-36) I decided to investigate its possibilities. This paper gives an account of the technique I finally evolved and of the results.

Technique.—The operation is performed under general anæsthesia and the site of the incision is infiltrated with weak adrenaline solution. The incision starts at Shrapnell's membrane and ascends the outer attic wall to the roof of the external auditory canal (Fig. 1). It then traverses the roof in the mid-line. At the junction of the osseous and cartilaginous canals it turns downwards and outwards. This marks out an elliptical flap which is easily elevated. The incision is made with a fine knife *via* a slotted aural speculum and it is easy, using one edge of the slot, to catch the flap and roll it into the floor of the meatus. A little hæmorrhage occurs and is easily controlled by pressure of the speculum. When it is mopped or sucked away, the whole bone of the outer attic wall and post-superior wall is clearly seen. This approach sacrifices no skin and is confined strictly to the osseous canal.

The bone removal should always commence at the tympanic ring. Fine labyrinth gouges 2 to 3 mm. in width are used to excise semilunes of bone as in Fig. 2. This is the "mauvais pas" of the operation because the facial nerve is in the direct line of the gouge. It is, however, a good sixth of an inch away and, with reasonable care, it need never be damaged. The bone at the tympanic annulus is very thin and can be cut away with the gentlest of hammer blows. The aditus and the short process of the incus, the facial nerve, and the stapes come into view almost at once, giving perfect orientation. The cavity is extended by progressively flaking semilunes of bone from the cut margin. It is tempting—especially in deep narrow ears—to try and enter the antrum at a more superficial point T (Fig. 2), but that is a very grave mistake for the following reasons: first, it is much more difficult to cut a hole than to flake off an edge of bone, and the operator is easily disorientated (incidentally, the dental drill has no place in this operation). Also, if the antrum is successfully entered at T there still remains the "bridge" between it and the annulus which has ultimately to be removed under the added disadvantage that it

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tends to be obscured by blood seeping down from the cut bone above it. By the flaking method the surgeon always has a clear view of the dry edge of bone which he has to remove.

It is useless to attempt this operation with punches. A punch delicate enough to permit of use under direct vision could not bite the bone away. A more powerful punch completely blocks the view and, being used blind, is dangerous, dislocation of the incus is almost certain to occur. The same objections apply to attempts to "protect" the facial nerve by passing a Stacke director into the aditus. This obscures the field, dislocates the incus and may indeed bruise the nerve. The only satisfactory method is to use sharp gouges as described above.

It might appear at first sight that three hands are needed—one to hold the retractor, one to hold the gouge and a third to hold the hammer. That apparently has been the practice on the Continent. Thies entrusted the hammer to his assistant—a laborious and precarious technique. Heermann constructed special self-retaining retractors so that he could do the hammering himself. The most valuable retractor is a slotted speculum. A set should be available rising in half millimetres from 4 to 8 mm. The largest possible speculum should be used so that the pressure is maintained on the cut flaps, thus ensuring hæmostasis.

The extent of the operation is determined by the findings. If necessary, the whole mastoid process can be explored by excising the intervening bone. The anterior pouch of the attic should be left till the last, when the surgeon is well orientated and has adequate space to manœuvre. The bone in that region is commonly rather thick but is readily removed by the same technique of progressively flaking off the cut margin. Thus the incudo-malleolar articulation is exposed and the decision finally made as to the fate of the incus (Fig. 3). The ossicle is often submerged in granulations but providing the incudo-stapedial articulation is intact it is justifiable to retain it. These cases commonly recover with excellent hearing. Even if suppuration persists, it is easy at a subsequent operation to pick out the diseased ossicle. The fate of the malleus depends on the incus. There is nothing to be gained functionally by leaving the malleus by itself, but the attached drum helps to protect the inner wall of the tympanum. Even so it is advisable to amputate the head of the malleus which is prone to necrosis.

The operation cavity is carefully irrigated and examined for loose spicules of bone and granulation tissue. Then the skin flap is rolled into place. It laps over the facial ridge and covers the raw edges right up to the semicircular canal. This is a most important feature of the operation (Fig. 6). The functional results of mastoid surgery are greatly influenced by the rapidity with which epithelialization and healing of the aditus occur. In radical mastoidectomy, the surgeon is careful to sling the flap with sutures externally, but pays little attention to the state of affairs deep in. Consequently the aditus and facial ridge are only too often permanently covered with granulations. In attico-antrotomy the flap is gently smeared into position and then Zelex penicillin is squirted in (see page 326). No sutures or ligatures of any kind are necessary.

The first dressing is done about a week later and consists merely of syringing the Zelex out. The whole after-treatment is painless, a most important feature,

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especially when dealing with children. Nothing more than the simplest of aural toilets is necessary. In some cases the ear is dry within three weeks. Frequently however, small granulations form in the roof at the site of the original incision. If neglected these grow downwards and obstruct the atticostomy. They do not adhere to the facial ridge because the latter is protected by the skin flap. The granulation should be gently snared off under cocaine anæsthesia, after which the cavity usually heals rapidly. In general, one may confidently expect a healed cavity within four to six weeks. In those cases which prove resistant the trouble is usually in the tympanum and not in the mastoid cavity.

Rationale.—This underlines the rationale of atticotomy. In chronic otorrhœa the disease is in the middle ear, attic and aditus. The stress which has been laid on the idea of disease ramifying throughout the mastoid process has distorted the picture. Despite the exhortations of many authorities it is common practice to exenterate the mastoid process in search of outlying disease. Lempert (1938a), for instance, specifically states that a radical mastoidectomy should start with a complete exenteration of the process exactly as in a cortical mastoidectomy. We must condemn this attitude. From the practical point of view, it is shown to be unjustifiable by the fact that the limited excision of attico-antrotomy will produce better results by far. As to the theoretical point of view, let us remember that in the great majority of these cases there are no outlying cells—diseased or otherwise. The process is hypoplastic and is of the ivory or diploetic type. Again chronic middle-ear suppuration is a very benign condition in 60 per cent. to 80 per cent. of cases it yields to simple hygiene of the outer ear. We deduce that in those cases there can be little or no involvement of bone, and that the disease must be confined to the accessible soft tissue adjacent to the tympanic ring. In the remaining intractable cases, why must we fly to the opposite extreme of very radical surgery? Surely there must be intermediate stages between the benign condition which we cure by simple hygiene and this desperate condition which demands complete mastoidectomy. Those intermediate stages will consist of a little caries of the tympanic ring—or of the ossicles and perhaps some accumulation of granulation and debris in the aditus or antrum. It follows that the operation of choice will *commence* at the tympanic ring and not *finish* there. In this way the main focus of the disease is immediately exposed and the surgeon can be guided by his findings. If the appearance suggests more extensive disease there is no difficulty whatsoever in following up.

It seems to me that the heroic quality of the classical transmastoid approach (Fig. 4) has crept in because of our obsession with the intracranial complications. These loom too largely in our minds and in our textbooks. Whatever may have been the case in the past, to-day they are interesting rarities. I will concede readily that where such complications are suspected, the widest possible exposure is necessary and can only be provided by extensive circum-aural incisions. But these cases are rare, and they will become even rarer if we begin to pay attention to the functional significance of chronic otorrhœa. I am the last person to advocate indiscriminate surgery. Nevertheless I submit that any suppurating ear which has resisted conservative treatment should be explored by the transmeatal route without delay. In that way we could abolish the group of intracranial complications which is caused by neglected chronic

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suppuration More than that, we could give our patients some prospect of retaining, if not improving, their hearing Is it an exaggeration to say that we are reluctant to do a radical mastoidectomy if hearing is good We fear to make it worse We prefer our patient to be deaf so that we can operate with impunity Even if otorrhœa persists after the operation and deafness is as bad, or worse, we can claim to have saved him from the dreaded intracranial infections The following extract expounds that viewpoint —

Objects sought in operation —There are two principal reasons why the radical mastoid operation should be done first, for the relief of an annoying and at times offensive otorrhœa, and second, the prevention of intracranial complications, which are always serious This does not mean that the radical operation should be resorted to in all cases of chronic suppurative otitis media which do not wholly recover under conservative methods of treatment Every case of chronic otorrhœa does not present the same degree of potentially serious complications and each must be dealt with on its own merits When the suppuration continues as the result of carious erosion or a necrotic process, intracranial complications are threatened, but on the other hand, if the disease is confined to the mucosal lining of the tympanum, it is quite unlikely that intracranial complications will arise, thus contra indicating a radical operation —Jackson, C, and Coates, G M, 1929 *The Nose, Throat and Ear and Their Diseases*, pp 537-8, London

The writer of that article is led to the conclusion that mere persistence of discharge is not necessarily an indication for operation That is an attitude which I most strongly oppose Persistent otorrhœa is an indication for exploration of the attic and antrum I will except the occasional cases of eustachian infection which resist treatment They are rarities Most eustachian infections are readily controlled by hygiene—ionization and attention to the nasopharynx The vast majority of intractable cases have a post-superior or a Shrapnell perforation In them pus is seeping over the floor of the aditus, filling Prussak's pouches and eroding the incus If we think of such cases from a point of view of function, we shall regard them with the same urgency as the oculist regards chronic glaucoma

Our aim must be to save the incus It is generally held that the functional results of radical mastoidectomy are not improved by preservation of the incus and that otorrhœa may persist if a diseased ossicle is retained Those are the penalties we pay for the delayed operations The position is quite different in atticotomy I now have a number of patients on whom I have been able to preserve a functioning incus and in every case the hearing is excellent This is particularly important in the children of the poorer classes amongst whom bilateral middle ear suppuration is so common How are we supposed to treat these cases? MacCuen Smith advises as follows

"It not infrequently happens that young children suffer from a bilateral chronic otorrhœa which resists persistently all non operative measures for relief It has been my custom with these children to perform first a simple mastoid operation on the ear in which the hearing is more impaired, on the theory that the principal pathology is located in the mastoid antrum and this procedure corrects the otorrhœa in a

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fair number of instances. If the disease is not eradicated by this means, then a modified radical mastoid operation, which completely exposes the antrum, should be tried. This failing, we should seriously consider the advisability of performing the radical mastoid operation, selecting the worse ear first and noting the effect on the hearing, and should still further postpone additional operative measures if audition has been seriously impaired unless further complications threaten."—S. MacCuen Smith : Jackson and Coates, *The Nose, Throat and Ear and their Diseases*, 542.

It is not difficult to detect an undertone of defeat in these recommendations, and the reasons are not far to seek. If the primary disease is in the aditus and attic, then exenteration of the mastoid process can do no good at all. This fallacious idea underlies Heath's operation and also Bárány's operation of mastoidectomy without a meatal plastic. Both these procedures are uniformly disappointing.

During the past year, I have operated on thirty-five school children. In no case was there the slightest complication. Nearly all of them left the hospital within a week and in most cases the ear was dry within a month to six weeks. Unfortunately these children are still not discovered soon enough—or the operation is postponed too long in the hope that conservative treatment may ultimately succeed. There is no real difficulty in recognizing the ear which is not doing well. It continues to seep a little foul pus—or it heals and then breaks down again. These cases should always be explored promptly.

Criticisms.—In the past this operation has been subjected to fierce criticisms. We may list them as follows : (1) Performed in the dark in a pool of blood. (2) Insufficient room for manipulation. (3) Danger to vital structures—stapes, facial nerve ; dura and lateral sinus. (4) Cannot with certainty reach limits of disease.

(1) The operation is performed in the brilliant light of a bull's eye reflected by a head mirror down a large aural speculum. Hæmorrhage is reduced to a minimum—first because the incision is a minute one and secondly because the soft tissues are firmly compressed by the aural speculum. Thus, no blood seeps from above down to obscure the point of attack. A little blood may well up from the depths but is easily absorbed by a pledget of wool. By flaking the bone from below upwards (i.e. from within outwards) one keeps the point of attack well in sight all the time. It is always above the tide mark of the blood. It is of course necessary periodically to irrigate and suck out blood and pus so as to clarify the situation but I have never had to cut short any operation because the field was obscured with blood.

(2) It is true that the approach is constricted. The skin flap is perhaps half as big as a postage stamp and instruments have to be correspondingly delicate. The operation is admittedly difficult and demands meticulous care and precision.

(3) The danger to vital structures looms too largely in the imagination of the theoretical critic. Thies (Junior), declares that his father operated on 1,500 cases without a death and with very few major complications. I have myself performed over 300 attico-antrotomies without a single death. In three cases I have caused a transient facial palsy (i.e. subsiding within two weeks) ; in one case a labyrinthitis supervened which was cured by penicillin. I have never

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injured the lateral sinus and although I have frequently exposed the dura of the middle fossa, I have never torn it or set up any intracranial complications

(4) This criticism loses its force when we recall the pathological conceptions on which the operation is founded. In these cases we are dealing with localized disease in attic and aditus. The antrum is usually involved in that its lining is unhealthy. Outlying cells are few and the whole tract recovers rapidly when it is adequately drained. It should not be thought that this limits attico-antrotomy to a small proportion of cases. Leaving out the rare cases in which intracranial complications are suspected the transmeatal route is applicable to at least 90 per cent of all cases. The real refutation of these criticisms lies in the results. It is impossible to brush aside the statistics quoted by Thies and an analysis of my own cases shows that the *transmeatal operation* can yield results which are in every way superior to the classical operation.

Advantages—The intrinsic merits of the operation emerge when we compare it with alternative techniques. Although Shambaugh finds it identical with ossiculectomy the very names indicate the fundamental difference between ossiculectomy and atticotomy. In ossiculectomy the surgeon assumes the middle ear structures are useless and proceeds to ablate them. In atticotomy the stress is on function. The surgeon is out to preserve. He explores the attic and antrum being guided entirely by the pathological findings. It is said that the end result is the same, but this is incorrect. It is true that in atticotomy the incus frequently must be sacrificed. The fault lies not in the operation, but in the fact that we do it too late. The following account of ossiculectomy is extracted from Jackson and Coates' textbook.

Ossiculectomy may be done under local anaesthesia but is quite painful. Membrana tympani circumsised from ring—cut away from malleus, and removed.

TO EXTRACT MALLEUS

- (1) *American method*—Insert angled tenotome behind malleus and scrape it down—thus dividing ligaments and tensor tympani. Body of bone seized by Sexton's upward grasping forceps and delivered. Traction on handle alone is usually disastrous resulting in fracture.
- (2) Delstanche Brunschwig upward cutting ring curette is slipped up the manubrium, etc., etc.

REMOVAL OF INCUS

A choice of methods. It may disappear altogether unless preliminary disarticulation from stapes has been done. *Continental school* uses right and left incus hooks. *American operators* prefer opposite rotation of the incus hook. Accidents are not infrequent. Sustained pressure by hook may damage facial nerve. Too strong backward pressure may lose ossicle in aditus, antrum, attic pouch, hypotympanum or eustachian tube mouth. Successful in 40 per cent to 60 per cent. Merits wider study and eventual employment of younger surgeons of special deftness.

One must be struck by the multiplicity of manœuvres described, the variety of instruments necessary to perform them and the many disasters which are liable to attend them. The removal of the malleus under direct vision during a radical operation commonly requires considerable force and it must be difficult,

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dangerous and painful to scrape it from under cover of the outer attic wall. This blind groping can surely not be compared with the simple precision of atticotomy in which the ossicles are clearly exposed and examined before disposal. Nor is ossiculectomy likely to succeed unless the carious annulus is removed and the aditus drained. Efforts are indeed made to utilize an attic punch for that purpose, but as I have already pointed out the bone punch is futile and dangerous in that situation. In brief, ossiculectomy abandons the ossicles without a struggle. In this it is too radical. On the other hand it is too conservative in dealing with the disease. It cannot be extended at will. Any effort to use punches merely scrapes away the skin of the attic wall.

The issue between attico-antrotomy and the various transmastoid operations has already been touched on but the main difference may be usefully summarized. First, although attico-antrotomy is perhaps the more difficult operation—it is from the patient's point of view much smaller in every way. It takes from twenty to forty minutes. No sutures or ligatures are *ever* used and the manipulation of the soft tissues is reduced to a minimum. With the advent of sulphonamides and penicillin the post-operative complications of mastoidectomy have become rare, nevertheless they do still occur. We may note hæmorrhage, stitch abscess, perichondritis, secondary sloughing and post-aural fistulation, collapse of the pinna and so on. None of these complications ever occurs in atticotomy. Again the post-operative dressings and after-care of a mastoidectomy do still entail much pain and misery. After atticotomy there is practically no pain or discomfort. Healing is achieved much more rapidly and the discharge is never copious or offensive. The functional results of attico-antrotomy are in my opinion unquestionably superior to those of the radical operation. This I attribute to the following factors:

- (1) Preservation, where possible, of the incus.
- (2) Accurate positioning of skin flaps over the aditus floor. This prevents formation of granulations at that point and promotes rapid epithelialization of the cavity.
- (3) Minimal excision of bone and minimal displacement of soft tissues. The radical operation leaves a comparatively large cavity which has to fill secondarily with granulations. These then contract down and are more or less covered with skin. It is agreed that one of the most important factors of function is the promotion of rapid healing. The atticotomy cavity has practically no raw area to heal, with the exception of the anterior edge of the incision to which I have already referred. Healing time is thus reduced to less than half of the time required by mastoidectomy with correspondingly good effect on hearing.
- (4) In mastoidectomy the surgeon burrows from the surface downwards forming a conical cavity. The functioning tissues are reached towards the end of the operation, lying deep in the apex of the cone and liable to be obscured by blood seeping down from all sides. In the technique I have described the ossicles and aditus are exposed immediately and examined. The surgeon is always above the blood and cutting away from it rather than delving into it. He is thus able to preserve the functioning structures under direct vision all the time.
- (5) The mastoidectomy cavity—even when apparently quite dry—can be a source of recurring trouble to the patient. Sometimes it is so widely open



FIG 1

Transmeatalattico antrotomy The incision
Note the granulations on the post superior
quadrant of the tympanic ring The tym-
panic membrane in that region has collapsed
on to the inner tympanic wall

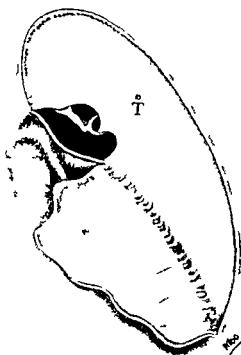


FIG 2

Transmeatalattico antrotomy The mauvais
pas The flap has been elevated and is now
thrust into the floor of the external auditory
canal The first two semilunes of bone
have been chipped away carrying the
granulations with them The long process
of the incus comes into view and the crura of
the stape The antrum could be reached by
plunging a dental drill through the post
superior meatal wall at T This is not
recommended (see text)



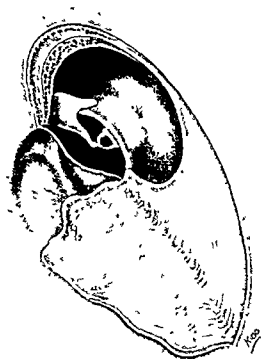


FIG 3

Transmeatal attic antrotomy The bone excision completed Showing incus, semi-circular canal, facial nerve and stapes This shows a comparatively limited excision of bone The exposure can easily be extended forwards, upwards or backwards The strip of bone overlying the head of the malleus would normally be removed so as to gain access to Prussak's pouch

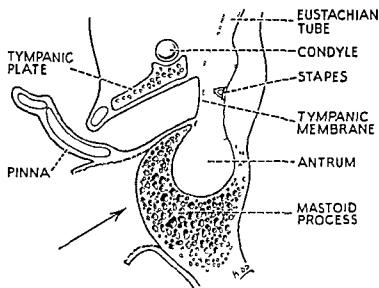


FIG 4

Classical radical mastoidectomy Showing post-auricular incision and radical excision of mastoid process (shown by shaded area)



that draughts of cold air can set up calorific effects on the labyrinth. The wax-bearing area is displaced into the cavity and so waxy crusts are liable to accumulate. The lining membrane is of poor vitality and is readily ulcerated by this mass. By contrast the atticotomy flap does not encroach on the wax-bearing area, so that crusts do not accumulate. The tiny cavity is lined by tough healthy skin and is tucked deep in out of harm's way. In favourable cases the patient is completely free of any further symptoms.

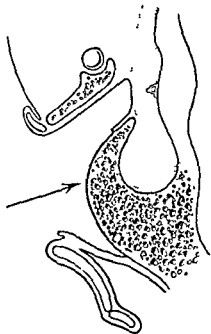


FIG 5

Lempert's endaural antiauricular mastoidectomy. Showing endaural excision of concha and radical excision of bone as in Fig 4

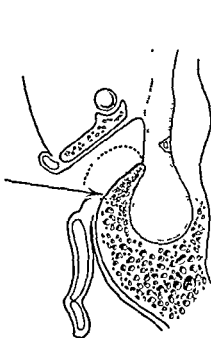


FIG 6

Transmeatal attico-antrotomy (author's technique). Dotted line shows skin flap turned downwards. Note limited excision of bone (shown by shaded area)

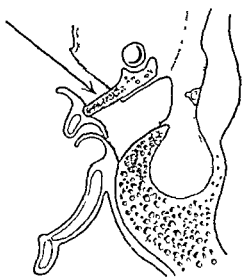


FIG 7

Transmeatal attico-antrotomy (Popper's route). A pre-auricular incision is made so as to expose the tympanic plate. This is excised and the external auditory canal is entered through its anterior wall. Bone excision as in Fig 6

The endaural antiauricular approach.—Many of my colleagues seem to confuse the approach described by Lempert (Fig.5) with the true transmeatal approach. Actually a comparison of the two techniques reveals that there is no resemblance whatsoever between them. Lempert (1938b) indeed specifically states in describing his approach :

The endaural antiauricular operation on the temporal bone is not performed through the external auditory canal, but through a widely-opened mobile window, which, together with the auricle, may be displaced in every direction over the temporal bone.

The differences may be summarized as follows :

- (1) Lempert forms a window by excising a triangle in the soft tissues of the outer half of the canal.

The true transmeatal approach sacrifices no skin and is limited to the osseous canal.

- (2) Lempert starts by plunging a dental drill down into the antrum.

In my opinion the dental drill is a bad instrument, especially when suppuration is present. This leaves the bridge to be dealt with later on. I have already discussed the disadvantage of this procedure.

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- (3) Above all, however, Lempert prescribes a radical excision of the whole mastoid process:-

His operation is essentially a transcortical mastoidectomy. It only differs from the classical operation in that he approaches the cortex in front of the concha instead of behind it.

The following extract from his description shows how radical Lempert's endaural mastoidectomy is :

The surgeon must expose tegmen, zygoma, base of the petrous—the sinus plate and the fallopian canal. He must venture posterior to the entire course of the lateral sinus and burrow down to the tip of the mastoid infero-anterior to the lower curve of the lateral sinus. He must expose the tympanic orifice of the eustachian tube, destroy the processus cochleariformis and avulse the tensor tympani.

It is not likely that this operation will leave much useful hearing.

Popper's route (1946a) (Fig. 7).—Mention must also be made of Popper's route in which extra space is obtained by partial excision of the tympanic plate. The route is proposed really for fenestration and similar procedures for which indeed it may have real value. Popper has, however, suggested that his route might be useful in otorrhoea. This is unlikely for the following reasons: the surgeon will be reluctant to open up clean tissue spaces—especially close to the temporo-mandibular articulation in the presence of chronic sepsis. Furthermore there is no real need for the extra space thus obtained in view of the fact that ample exposure is already obtained by the technique herein described.

Indications.—The fundamental difference between atticotomy on the one hand and ossiculectomy and classical mastoidectomy on the other hand is most clearly brought out in considering the treatment of attic suppuration presenting *via* a small perforation in Shrapnell's membrane. The discharge is minimal but intractable. The hearing commonly remains excellent for many years. In these cases ossiculectomy is mischievous. It inevitably impairs hearing and may not cure the suppuration. Radical mastoidectomy has just as bad an effect on hearing and leaves a large cavity which may continue to discharge even more than before. Atticotomy achieves exactly what McKenzie proposed. I have performed the operation frequently in this sort of case and almost always preserved the incus. The tiny cavity heals remarkably quickly and the hearing remains excellent. It should, however, not be imagined that atticotomy is only indicated in this limited group of cases. On the contrary, I would say that once a surgeon has fully mastered the technique he will use it to the exclusion of all others. The only exceptions are: (1) cases in which intracranial or other complications are definitely suspected. (2) Cases in which the soft tissues of the meatus have become chronically thickened and deny access to the deep meatus.

A thorough familiarity with the transmeatal technique is invaluable in dealing with many other conditions also. Despite injunctions to the contrary I have had no difficulty in removing osteomata of the osseous canal. Secondary ossiculectomy (when a previous conservative mastoidectomy or atticotomy has failed) is performed with the utmost ease and I have converted many Heath operations into radicals by the same technique. In the past I have also

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performed attico-antrotomy on a few cases of cortical mastoidectomy in which suppuration had persisted. It is noteworthy that Lempert's latest operation of tympanic sympathectomy is transmeatal and I believe with Popper (1946b) that functional surgery of the ear will in the future be more and more associated with this route.

Results—In an effort to assess the value of atticotomy, a questionnaire was sent to fifty consecutive cases.

Forty-two replies were received, yielding the following figures.

All age groups were represented from 5 to 65.

<i>Duration of disease</i>		<i>Average stay in hospital after operation</i>	<i>7 days</i>
Under one year	1	<i>Post operative pain</i>	
1 to 3 years	13	None	28
3 to 20 years	14	Slight	13
Over twenty years	14	Severe	1

It is clear that we are very far from our ideal of "early operation."

<i>Healing</i>		<i>Healing time</i>	
The cases were then examined to		1 to 3 weeks	14
check the condition of the		3 to 6 weeks	11
cavity		6 to 12 weeks	2
Completely dry tympano-		Over 12 weeks	2
mastoid cleft	29		
Dry mastoid cavity but	} 38 healed		
slight discharge from		<i>Effect on hearing</i>	
middle ear		Improved	21
	9	Unaltered	19
		Worsened	2

Slight discharge from mastoid as well as middle ear 4

In no case was there any gross purulent discharge.

These figures were analysed as follows by the Department of Applied Mathematics, Liverpool University (Professor L. Rosenhead).

With data of this nature it is convenient to calculate two limits within which the true proportion (e.g. of moist mastoid cavities) may be expected to lie. More precisely, we give below an upper and lower limit such that, if the experiment were repeated many times under the same conditions and these limits calculated in the same way each time, then the true proportion would lie between these limits in 95 per cent of cases, outside in only 5 per cent.

We find

(1) *Mastoid cavity* Proportion 'moist' almost certain to lie between 2 per cent and 24 per cent (and therefore 'dry' between 76 per cent and 98 per cent).

(2) *Middle ear cavity* Proportion "moist" almost certain to lie between 17 per cent and 48 per cent (and therefore 'dry' between 52 per cent and 83 per cent).

(3) *Hearing* With a probability of being correct lying between 92.5 per cent and 97.5 per cent we may assert that the proportion "improved" lies between 20 per cent and 67 per cent. "Unaffected" between

15 per cent. and 62 per cent., while the proportion "impaired" is less than 18 per cent.—(R. L. Plackett, 24.4.47.)

The following conclusions may justifiably be drawn from these figures :

(1) Since 38 operation cavities out of 42 healed completely and since the remaining four do not produce any gross purulent discharge, attico-antrotomy is quite adequate for dealing with the disease in the mastoid process. The fear of leaving outlying disease is without foundation.

(2) When healing occurs it does so far more rapidly than after a radical operation. The figures quoted are the patients' estimates and no doubt some reported a dry ear in the absence of overt discharge when in fact epithelialization was not quite complete. Several in fact reported a dry ear after the first dressing. Even allowing for this exaggeration it is clear that, in successful cases, healing takes place with gratifying rapidity. In six cases the patient was discharged as cured after the fourth dressing.

(3) The effect on function is also gratifying. The following audiograms appertaining to four children (shown at the Otological Section of the Royal Society of Medicine on February 7th, 1947) demonstrate what can be achieved in suitable cases. In each case there had been bilateral chronic suppurative otitis media for many years. Conservative treatment cured one ear but failed in the other. Atticotomy was then performed on the infected ear. In each case there was a substantial improvement in hearing although in no case was the operated side as good as the opposite side.

To sum up.—(1) Transmeatal attico-antrotomy is described and proposed as the method of choice for dealing with intractable non-complicated otorrhœa.

(2) It is a minor operation from the patient's point of view. (3) It is possibly more difficult than transmastoid operations. (4) It is *not* a dangerous operation.

(5) Its results are extremely satisfactory.

Acknowledgements.—I am happy to acknowledge my indebtedness to Mr. R. L. Plackett for the statistical analysis and to Mr. H. Zalin who has assisted me indefatigably, not only in the theatre, but also in the Out-patient department, where the vitally important after-treatment is given.

On the use of Zelex penicillin :

(1) The Zelex should be dry sterilized in small quantities in separate test tubes.

(2) Any moisture sterilizing will denature it.

(3) Even at best there is always some impairment of the "gelling" quality. Therefore a batch should never be re-sterilized. Throw any surplus away.

(4) Mix the powder with penicillin solution of required strength. I use 5,000 units per c.c. The proportions required are easily determined by trial.

(5) When the mixture is still fluid suck it up into a Watson-Williams syringe using the straight sphenoidal cannula.

(6) Wait till the mixture has set to a gel, i.e. it just emerges from the cannula in a semi-solid consistency.

(7) Squirt it into the cavity under direct vision.

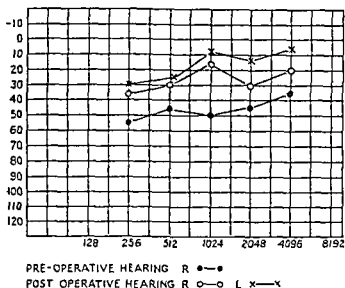


FIG 8

Audiogram of R.L., aged 11 History Bilateral chronic suppurative otitis media, three years Left ear recovered with conservative treatment Right ear resisted treatment Right ear—post-superior perforation with purulent otorrhoea Operation Right transmeatal atticotomy, 21.1.46 In hospital seven days Ear healed in seven weeks Incus preserved Average hearing gain 21 db

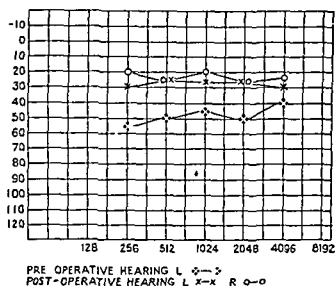


FIG 9

Audiogram of E.P., aged 13 History Bilateral chronic suppurative otitis media, three years Right ear recovered with conservative treatment Left ear resisted treatment Left ear—post-superior perforation with purulent otorrhoea Operation Left transmeatal atticotomy, 21.1.46 In hospital seven days Ear healed in seven weeks Incus preserved Average hearing gain 21 db

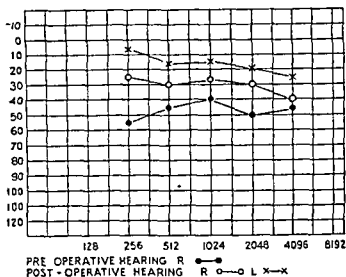


FIG 10

Audiogram of I.G. aged 10 History Bilateral otorrhoea when teething condition subsided but recurred when she entered school Intermittent otorrhoea five years Conservative treatment cured left ear but failed to cure the right Right post-superior perforation with purulent otorrhoea Operation Right transmeatal atticotomy In hospital five days Ear dry in seven weeks Incus preserved Average hearing gain 17 db

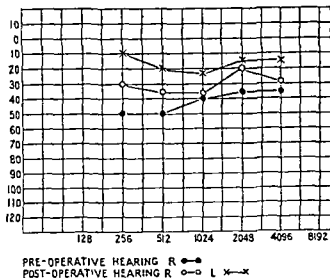


FIG 11

Audiogram of P.S., aged 11 History Bilateral otorrhoea two years ago (also otorrhoea in infancy) Intensive conservative treatment for two months cured the left otorrhoea but not the right Right ear—post-superior perforation with purulent otorrhoea Operation Right transmeatal atticotomy, 25.3.46 In hospital five days Ear dry in six weeks Incus preserved Average hearing gain 12 db

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definitely that he could get better results than he ever got with any other operation. He expected the operation cavity to dry and he was disappointed if it did not.

When the ear continued to discharge it discharged from the middle ear. His case No. 1 was a man who had a radical operation in childhood. His other ear became infected, and he came to him after eighteen months obviously very deaf. He treated him for three months before he finally operated. He operated and preserved the incus. The middle ear was still moist, but instead of a gross purulent discharge, there was a slight mucoid discharge which came from the middle ear. Ears which did not dry after an attico-antrotomy failed to do so because of discharge seeping from the middle ear and not from the mastoid. In the cases of partial cure the partiality of the cure was not due to disease in the mastoid, and those cases which did persist were reduced in number, if operated earlier. Early operation was a necessity. He was thinking not so much about adults, but about children. Many children of the working classes had bilateral otitis media, and were going to be crippled if surgeons did not save them. He had brought four of them to that meeting, and he had done thirty-five cases during the year, every one of those thirty-five had a dry cavity.

Complications did occur after radical operation, but they should not be common. He did not suggest that these occurrences were a grave disadvantage of the radical, but still they did occur.

On the question raised by Mr. Reid as to whether attico-antrotomy was effective when the child got an acute ear, it was essential to distinguish quite clearly between acute otitis media and the chronic infection for which he did this transmeatal attico-antrotomy. Most of these children did not have a properly developed pneumatic system of their mastoid and they were not liable to typical acute mastoiditis. Cases were seen in which the ear continued to seep discharge from the eustachian orifice, but not from the attic if an attico-antrotomy had been done. The child was not liable to acute mastoiditis because the mastoid was not pneumatized.

As to how one managed a procedure which was sometimes said to demand three hands, there was no difficulty in putting in the speculum, but it must fit tightly.

THE PRESIDENT, in closing the discussion, said that he was familiar with Mr. Tumarkin's work and the good results which, in chronic middle-ear suppuration, followed his operations by the external meatal route, but as Mr. Watkyn-Thomas had remarked, many of us, accustomed to operate from behind the auricle, found it easier to do so and further cholesteatomatous invasion at times was remarkably extensive, filling the cells of the mastoid apex even in young children.

The more slender standard gouges appeared too thick in the shaft for these operations though Mr. Tumarkin had had some improved in the workshop. He had also spoken of the use of "the third hand". He (the President) made use of this regularly in the intranasal approach to the bone overlying the lacrimal sac and in "taking down" the crest in operations on the nasal septum.

Perhaps an assistant in the role of "Blacksmith's striker" might also be helpful to those deciding to operate upon the tympanic attic and antrum by the meatal route. Regulation of the force applied had not been at all difficult in intranasal work.

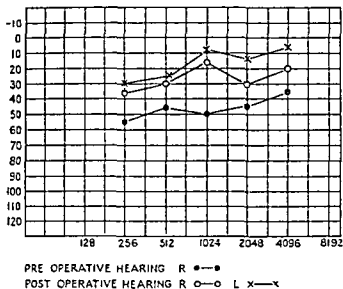


FIG 8

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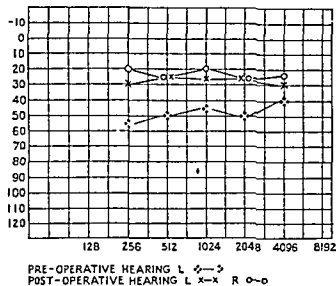


FIG 9

Audiogram of E P, aged 13 History Bilateral chronic suppurative otitis media, three years Right ear recovered with conservative treatment Left ear resisted treatment Left ear—post superior perforation with purulent otorrhoea Operation Left transmeatal atticotomy, 21.1.46 In hospital seven days Ear healed in seven weeks Incus preserved Average hearing gain 21 db

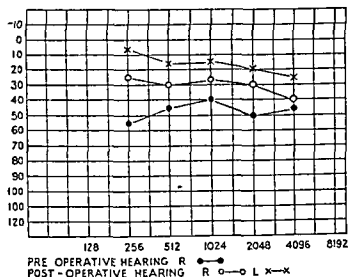


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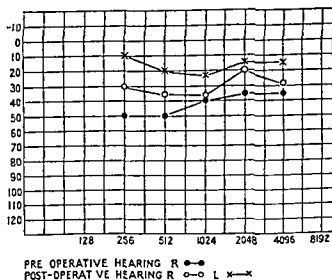


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Audiogram of P S, aged 11 History Bilateral otorrhoea two years ago (also otorrhoea in infancy) Intensive conservative treatment for two months cured the left otorrhoea but not the right Right ear—post-superior perforation with purulent otorrhoea Operation Right transmeatal atticotomy 25.3.46 In hospital five days Ear dry in six weeks Incus preserved Average hearing gain 12 db

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- (8) Zelex must not be poured in whilst still fluid. It can seep under flaps or into the middle-ear cleft and act as a foreign body.
- (9) Remove seven to fourteen days later by gentle syringing and if necessary morcellement.

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MR. F. W. WATKYN-THOMAS said that transmeatal methods had been practised for some eighty years and although they had achieved success in the hands of gifted surgeons, they had never been generally accepted. The reason for this was that the difficulties of the operation made the methods unsuitable for general application. Mr. Tumarkin had mentioned and condemned removal of the outer attic wall by a punch with the transmeatal method. This was described by West and Scott in their "Operations of Aural Surgery", London, 1909. When he was their house surgeon five years later—in 1914—he was forbidden ever to try anything of the sort. He could not see that the results were in any way superior to the modified radical, or, say, the transmastoid atticotomy. Here in his experience, and, he thought, in that of many of his colleagues, there was no danger to the hearing. The hearing was usually improved. The access was much easier, and he could not agree that it was necessary to remove the incus. If the incus was absolutely loose, lying in a mass of granulation, so that it came out of the end of a sucker, then he thought it was useless to leave it, but otherwise the incus could always be left intact. In fact one's guide for the operation should be to see the crus of the incus lying on the external canal.

Then came the question of accessibility. The majority of cases of attic disease were due to cholesteatoma, and he knew of no method by which one could tell, except by full exposure, how far that cholesteatoma extended. If there was cholesteatoma one could not remove it except by removing the matrix, and if the matrix extended far back into the antrum he failed to see how a surgeon, even of Mr. Tumarkin's ability, could reach it and eliminate it.

The second question of accessibility was in cases in which there was a mastoid structure where one had compact bone with a central chain of cells which had been destroyed by suppuration and had left a cavity—an empyema—in the mastoid. He knew of no way of detecting that except by exposing it. Therefore, although he was impressed by Mr. Tumarkin's skill and his excellent results, he must regard his procedure as retrograde so far as mastoid suppuration was concerned.

Royal Society of Medicine

MR R L FLETT desired to support Mr Tumarkin as against Mr Watkyn Thomas. Mr Tumarkin generally tried by previous X rays to find the limitations of work on the mastoid. He himself was very well satisfied with the transmeatal operation. He was also doing fenestrations through that route. He wished to pay a tribute to Mr Tumarkin's method.

MR TERENCE CAWTHORNE said that he thought that some form of meatal approach was becoming more popular in operations for chronic suppurative otitis media. He had been accustomed for some years to using the endaural approach, and he could see that there might be some advantages for what Mr Tumarkin described, but that it required suitable practice and considerable skill. Those who had seen large numbers of school children suffering from chronic suppurative otitis media would welcome the possibilities presented by this operation.

MR I SIMSON HALL had found a great many points of interest in Mr Tumarkin's paper, but he could not help feeling that if discharge continued in one of these cases as discharge will in a small proportion of all operations it would be very difficult for him to satisfy himself that some diseased cells had not been overlooked, but as Mr Tumarkin had not quoted any figures he assumed that Mr Tumarkin was satisfied that in his hands this operation gave better results than any other form of radical mastoidectomy in suitable cases.

MR W OGILVY REID spoke of the unfortunate tendency to recurrence of mastoid infection in children. Children seemed to be liable to acute reinfection of the mastoid cavity subsequent to operation. Some time before the late Mr G J Jenkins died he was working with him on a periosteal flap operation which he (Mr Reid) later published in 1942 (*J Laryng and Otol*, lvi, 405), the aim being to try to prevent the spread of any subsequent infection of the middle ear to the mastoid cavity formed by the operation. That flap operation had been very effective in limiting the spread, confining it to the middle ear. He wished to ask Mr Tumarkin whether he had found the recurrence rate diminished in any way by his particular technique. He wondered whether the provision of drainage from the attic cut short any subsequent attack of otitis media.

MR A TUMARKIN, in reply said that Mr Watkyn Thomas had raised what were, after all, the standard objections to the operation, and short of repeating what he had already said in the paper he could not say any more in answer to his objections. He believed that no particular difficulty would stand in the way of any competent surgeon carrying out what he had advised.

Mr Cawthorne had spoken of skill in the operation and in the after-treatment. One of the essential features of attic antrotomy was that the after-treatment was simplicity itself. Members must have been struck by the rapidity of healing in many cases he had shown. Of course, cases did come along which involved special difficulty nevertheless when he did an attic-antrotomy he expected to syringe the Zelex out a week or ten days later and to see the patient thereafter once a week for a month and, at the end of that time, no more trouble.

Mr Simson Hall had asked for statistics, but he did not know how his own figures could be quoted with any real significance against somebody else's. Attico antrotomy was an operation based on a definite conception of pathology. It set out to do certain things and it did them. Actually he would say quite

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definitely that he could get better results than he ever got with any other operation. He expected the operation cavity to dry and he was disappointed if it did not.

When the ear continued to discharge it discharged from the middle ear. His case No. 1 was a man who had a radical operation in childhood. His other ear became infected, and he came to him after eighteen months obviously very deaf. He treated him for three months before he finally operated. He operated and preserved the incus. The middle ear was still moist, but instead of a gross purulent discharge, there was a slight mucoid discharge which came from the middle ear. Ears which did not dry after an attico-antrotomy failed to do so because of discharge seeping from the middle ear and not from the mastoid. In the cases of partial cure the partiality of the cure was not due to disease in the mastoid, and those cases which did persist were reduced in number, if operated earlier. Early operation was a necessity. He was thinking not so much about adults, but about children. Many children of the working classes had bilateral otitis media, and were going to be crippled if surgeons did not save them. He had brought four of them to that meeting, and he had done thirty-five cases during the year, every one of those thirty-five had a dry cavity.

Complications did occur after radical operation, but they should not be common. He did not suggest that these occurrences were a grave disadvantage of the radical, but still they did occur.

On the question raised by Mr. Reid as to whether attico-antrotomy was effective when the child got an acute ear, it was essential to distinguish quite clearly between acute otitis media and the chronic infection for which he did this transmeatal attico-antrotomy. Most of these children did not have a properly developed pneumatic system of their mastoid and they were not liable to typical acute mastoiditis. Cases were seen in which the ear continued to seep discharge from the eustachian orifice, but not from the attic if an attico-antrotomy had been done. The child was not liable to acute mastoiditis because the mastoid was not pneumatized.

As to how one managed a procedure which was sometimes said to demand three hands, there was no difficulty in putting in the speculum, but it must fit tightly.

THE PRESIDENT, in closing the discussion, said that he was familiar with Mr. Tumarkin's work and the good results which, in chronic middle-ear suppuration, followed his operations by the external meatal route, but as Mr. Watkyn-Thomas had remarked, many of us, accustomed to operate from behind the auricle, found it easier to do so and further cholesteatomatous invasion at times was remarkably extensive, filling the cells of the mastoid apex even in young children.

The more slender standard gouges appeared too thick in the shaft for these operations though Mr. Tumarkin had had some improved in the workshop. He had also spoken of the use of "the third hand". He (the President) made use of this regularly in the intranasal approach to the bone overlying the lacrimal sac and in "taking down" the crest in operations on the nasal septum.

Perhaps an assistant in the role of "Blacksmith's striker" might also be helpful to those deciding to operate upon the tympanic attic and antrum by the meatal route. Regulation of the force applied had not been at all difficult in intranasal work.

ABSTRACTS

EAR

Healing of Experimental Labyrinthine Fistulas Further Observations
J R LINDSAY, M D (Chicago) *Arch Otolaryng*, 1947, xlv1, 5, 584-600

Further observations on factors influencing osteogenesis at the site of the labyrinthine fistula are presented and the rôle of the covering flap is considered in particular

The interpretation based on the previous experiments that success in maintaining a patent fenestra in a semi-circular canal is dependent on the degree to which the membranous canal is preserved in its normal position at the outer periphery of the bony canal, where it is free to come into direct contact with whatever covering may be used over the fistula, appears to be supported

R B LUMSDEN.

SYMPOSIUM ON FENESTRATION OF THE LABYRINTH

Lempert Fenestra Nov Ovalis Operation for the Restoration of serviceable unaided hearing in Patients with Clinical Otosclerosis Its present evolutionary status JULIUS LEMPERT, M D (New York)

Osteogenesis following Fenestration of the Vestibular Labyrinth of the Rhesus Monkey A controlled experimental study JULIUS LEMPERT, M D (New York), PHILIP E MELTZER, M D (Boston), LE ROY A SCHALL, M D (Boston), DOROTHY WOLFF, Ph D (New York)

Revision of the Fenestration Operation PHILIP E MELTZER, M D (Boston)
Medical and Surgical care of the patient selected for Fenestration of the Labyrinth K M DAY, M D (Pittsburgh)

Training of Surgeon and selection of patient for the Fenestration Operation J H MAXWELL, M D, Ann Arbor, Mich

General Correlation MARVIN F JONES, M D (New York) *Arch Otolaryng*, 1947, xlv1, 4, 478-548

In his article entitled "General Correlation", Marvin F Jones summarizes the lessons to be learned from this symposium as follows

- 1 "There is a definite and too great element of error in the present methods of arriving at a diagnosis which precludes dogmatism
- 2 "Training methods for the development of understanding, capable fenestration surgeons should be subject to the approval of authoritative bodies
- 3 "Certification of those trained in fenestration surgery should be implemented by the American Board of Otolaryngology at once as a protection to the public
- 4 "Anæsthesia for fenestration should receive more attention on the basis of blood control and safety.

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5. "The Lempert endaural fenestration operation performed by a competent otologic surgeon, properly trained, improves hearing to the useful level. The patient's hearing can be maintained for ten years in an indefinite percentage of selected cases. The figures reported thus far are so divergent that it seems inadvisable to state a definite percentage. I would feel justified in saying there is a permanent improvement in more than 50 per cent.

6. "A comment which I deem in order concerns the medical information liberated to the lay press. The public is entitled to know the applicable advances in medicine. Unfortunately, there has been no distinction between reporting experimental progress and reporting established procedures. The first enthusiastic statements are not apt to be the final, soberly considered deductions. The old pendulum idea holds also in medicine. The first flush of optimistic endeavour is sometimes followed by an overly pessimistic phase as the other extreme. Opinion will finally settle down to correct values."

R. B. LUMSDEN.

SYMPOSIUM ON VERTIGO BEFORE THE AMERICAN OTOLOGICAL SOCIETY (*A. in. Otol., Rhin. and Laryng.*, 1947, lvi, 514.)

The Symposium takes the form of four papers followed by a Summation.

I. *The Physiology of the Vestibular Mechanism in Relation to Vertigo.* W. J. McNALLY (Montreal), 514.

"Vertigo may be defined as a consciousness of discord in the postaural mechanism. Maintenance of posture depends upon information received, the labyrinth . . . (and other) so-called Kinesthetic sensations. This information is correlated in the consciousness, and conflicting information from any source, or failure of the central nervous system to co-ordinate this information leads to confusion in the mind of the individual; this is what we call vertigo or dizziness."

Following the above definition of vertigo, the study is divided into sections. The first is a concise review of the experimental work on the subject during the last hundred years, well worthy of reference, but so concise as to defy further abstraction. The second part is devoted to vestibular tests.

The Slow Tilt Test. Grahe describes two. In the first the patient, strapped to a frame is tilted from an oblique to the vertical position with his eyes closed. Failure to detect the vertical position is indicative of utricular dysfunction. In the second test, the patient is tilted about a horizontal axis. Normally the head should maintain the erect position; failure to do so again indicates utricular dysfunction. These tests have not received general acceptance.

The Rapid Tilt Test. The reaction of a patient to rapid tilting is primarily a test of vertical semi-circular canal function. It has the objection that, in a lesion of long standing compensation may develop and the reaction appear normal.

Caloric Stimulation of the Labyrinth. This test has the advantage over the rotation test that it stimulates only one labyrinth at a time, and over the galvanic in that it stimulates the end organ only and not the nerve. Bárány's Convection current theory is probably the best explanation of the reaction.

Kobrak's method of minimal stimulation is generally regarded as the best method of application. While it is known that the reaction may vary in the same subject from day to day, there is no evidence of habituation and lessening sensitivity with repeated stimulation. Recent experiments have cast some doubt on the validity of Ewald's Law of maximal and minimal stimulus.

It is stressed that "a clinical vestibular test must be as all informative as possible and yet it should be as simple as possible."

At the present time the vestibular tests in common use rely on the reaction of the eye muscles to vestibular stimulation. In point of fact the whole musculature of the body is under the influence of the labyrinth. It is probable that the tests will be more revealing when we have a greater knowledge of the response in other muscle groups.

II *The Symptomatology of Vertigo* ALFRED LEWY (Chicago), 534

Vertigo like headache may occur as a symptom of almost any ill to which the flesh is heir. The point of origin may lie in the field of internal medicine, otology, neurology or ophthalmology, but the symptom becomes manifest through disturbance or destruction of the vestibular centres of the brain.

Vertigo of peripheral origin is recognized by the associated aural manifestations, local objective lesion, deafness and tinnitus, and, if present, a falling reaction influenced by head position.

Many of the cases of vertigo not demonstrably due to local peripheral disorder are of toxic origin—focal infection, fumes (e.g. Carbon Monoxide) or drugs being administered for some other condition, a recent example being streptomycin. Diagnosis is by recognition of the potential cause and its elimination.

The majority of central causes of vertigo, affect other nerves than the VIIIth, and to a large extent their diagnosis depends on recognition of these associated findings.

Postaural nystagmus is, in the writer's opinion, invariably of central, generally subtentorial, origin, as also are all forms of vertical nystagmus. A coarse, persistent, slow nystagmus of vestibular type not influenced by head position, and increasing instead of decreasing with time suggests a cerebellar lesion, certainly if it is toward a dead labyrinth. A diminished or lost labyrinthine response may be due to either a central or a peripheral lesion, but a perverted response invariably denotes a central lesion.

The paper concludes with Leidler's classification of vestibular symptoms (*vide* Leidler, R. *Pract Otol, Rhin Laryng*, May and June 1939, II, 86 and 152).

(i) Vestibular symptoms suggestive of central nervous system disease

- 1 Severe attacks of dizziness over a long period with constant hearing
- 2 Unilateral or bilateral disturbance of vestibular reaction with constant normal hearing
- 3 Long lasting spontaneous nystagmus of at least second degree with normal hearing
- 4 Occurrence of severe headache or increase of existing headache simultaneous with severe dizziness
- 5 Perverted nystagmus reactions, especially predominance of the

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slow component and disturbances of rhythm (in the direction of conjugate deviation).

6. Postural nystagmus.
7. High grade nystagmus without dizziness, or if both are present independent of each other.
- (ii) Vestibular signs conclusive of central nervous system disease.
 1. Unilateral loss of hearing and vestibular response with spontaneous nystagmus of at least second degree, to the same side.
 2. Unchanged second degree nystagmus in the same direction for longer than a week.
 3. Continued second degree pure rotary nystagmus over a long period.
 4. All forms of vertical nystagmus.
 5. Unilateral or bilateral caloric inexcitability in the presence of normal hearing and normal rotation response.
 6. One phase reactions (conjugate deviation).
 7. Dizzy spells with loss of consciousness.
 8. Occurrence of long lasting changes of head posture during examination of the vestibular nerve, sometimes with somnolence or sleep.

III. *Pathology of Vertigo arising from the Peripheral Vestibular Apparatus.* J. R. LINDSAY (Chicago), 541.

1. The pathologic disturbances which are associated with most clinical conditions giving origin to pseudo-Ménière's syndrome (vertigo without auditory symptoms or central neurologic signs) are not known. The localization has rarely been proven. The postural vertigo which is a characteristic of this group usually corresponds to the type which is most frequent in proven disease of the posterior fossa in that a positional nystagmus occurs which changes direction with alteration of the position of the head. A central origin is therefore suggested.

2. Vertigo of peripheral origin has been satisfactorily explained in labyrinthitis of various types, tumors and fractures of the labyrinth.

3. In concussion of the labyrinth the pathologic lesion has not been adequately demonstrated. A temporary threshold dip at the C frequency has been shown. A subarachnoid hæmorrhage which extends along the vessels and nerves into the porus acusticus and even into the perilymphatic spaces is common after head trauma and following craniotomy.

The degree of hæmorrhage into the porus acusticus and the perilymphatic space which is necessary to interfere with function is, however, indefinite. Probably a frank hæmorrhage into the labyrinthine spaces is necessary for any marked disturbance of function.

The pathologic explanation for the apoplectic onset of deafness, tinnitus and vertigo in a previously healthy ear has not been demonstrated. An interruption of circulation or a hæmorrhage are considered to be most probable.

4. The pathogenesis of a toxic neuritis or neurolabyrinthitis is not clear in all cases. For example, the occurrence of progressive neural degeneration in otosclerosis, as well as that which sometimes occurs as a complication after the fenestration operation, has created special interest.

5. The histopathologic disturbance in idiopathic labyrinthine dropsy lacks an ætiologic explanation.

Degeneration of neural elements appears to be a late accompaniment of this type of hydrops, whereas in serous labyrinthitis the degeneration of neural elements occurs early

Degeneration of sensory structures within the endolymphatic spaces and the stria vascularis appears to parallel the development of hydrops in serous labyrinthitis but may be slight or absent in comparatively long standing cases of idiopathic hydrops (Author's Summary)

IV *Incidence of Vertigo in Neurological Conditions* I LEVY and J L O'LEARY (St Louis), 557

The neurological evaluation of vertigo as a symptom is dependent to a large extent on the associated phenomena. The author discusses the various locations of lesions which may give rise to vertigo. In general terms lesions of acute onset are more liable to produce this symptom than the more insidiously developing lesions. Vertigo has not been a particularly useful symptom in contributing to the diagnosis of cerebellar lesions.

Eight cases are presented in detail, illustrating different problems in the differential diagnosis of Meniere's Disease.

V *Summation* A C FURSTENBERG Ann Arbor, 576

1 Vertigo may be a symptom of some toxic disorder. Its occurrence in septic patients, after the administration of certain drugs and more recently of the antibiotic streptomycin, is considerable proof of this assumption.

2 Vertigo may be one of the manifestations of a nervous depression. The diagnosis is usually not difficult, although a satisfactory therapeutic response is not always obtainable. In this connection a word of caution is offered. The otologist must be careful not to do or say something that will fix the patient's symptoms upon some specific cause. When one offers a precise explanation for the patient's ills and assures successful results from treatment or an operation there is always the risk of a therapeutic failure and the permanent crystallization of the patient's symptoms. The sedative dilantin has seemed to benefit some of these patients.

3 Vertigo is occasionally a symptom of hypertensive disease. The prospect of relieving the patient of this troublesome condition is favourable if surgical measures result in a substantial reduction in blood pressure.

4 Organic lesions of the central nervous system may produce vertigo but they are usually associated conspicuously with other clinical signs of intracranial disease. The classical example is the cerebellopontine angle tumour.

5 There are instances when vertigo is the result of an end organ lesion in the acoustic nerve. The vertigo derived from this source, as for example that of Meniere's disease, is so specifically characteristic as not to be confused with any other type. I speak succinctly and without fear of derision that if the patient suffers a violent paroxysmal vertiginous attack—one that fells him in his tracks—we are dealing in all probability with an end organ lesion, not an intracranial disease. (Author's summary)

Note The above papers are so condensed that it is impossible to abstract them in any detail. Those interested in the subject are recommended to read them in their original.

Abstracts

ŒSOPHAGUS

Treatment of Œsophageal Varices by Injection of a Sclerosing Solution.
HERMAN J. MOERSCH, M.D. (Rochester, Minn.). *Jour. A.M.A.*,
November 22nd, 1947, cxxxv, 12, 754.

Roentgenological examination is of great value in the diagnosis of œsophageal varices but is not infallible. In doubtful cases œsophagoscopy should be employed.

The writer reports results of treatment in twenty-two cases of œsophageal varices in which gastro-intestinal hæmorrhage occurred. The patients were treated by the injection of sodium morrhuate into the varices through an œsophagoscope. All patients were followed for a period of at least three years. Twelve of the patients have had no further bleeding after treatment. Patients in whom unsatisfactory results were obtained, invariably were found to have varices in the cardiac end of the stomach as well as in the œsophagus.

Where the stomach is involved as well as the œsophagus, some other form of treatment such as portal caval anastomosis or the resection of the cardiac end of the stomach and the lower end of the œsophagus should be considered.

The article is illustrated, has three tables and a bibliography.

ANGUS A. CAMPBELL.

MOUTH

Diseases of the Salivary Glands. A. C. FURSTENBERG, M.D. (Ann Arbor, Michigan). *Jour. A.M.A.*, January 3rd, 1948, cxxxvi, 1, 1.

This discussion is limited to a consideration of parotid and submaxillary glands. The commonest cause of infection in these glands is due to the presence of a salivary calculus and its most frequent location is in Wharton's duct, although it sometimes occurs in Stensen's duct. When the gland is acutely inflamed, antibiotics and symptomatic treatment should be employed. During the quiescent period, the stone should be removed surgically by the intra-oral route. When the glands are chronically inflamed, it may be necessary to remove the whole gland by external operation.

Syphilis, actinomycosis and tuberculosis are rarely found. Injury and dehydration are potent factors in these infections. Pilocarpine therapy is frequently effective in inflammatory cases, accompanied by dehydration.

The commonest type of neoplasm is the mixed tumour. In its removal, the surgeon must not fail to eradicate the lesion completely for when it recurs, it usually presents carcinomatous changes and further surgical efforts are futile.

ANGUS A. CAMPBELL.

MISCELLANEOUS

Scleroma: A Clinico-Pathological Study of Seven Cases in one Family.
H. JAMES HARA, ORLYN B. PRATT, MILTON G. LEVINE and ROBERT E. HOYT (Los Angeles, California). *Ann. Otol., Rhin. Laryng.*, September, 1947, lvi, 769.

1. A detailed study on seven cases of scleroma from one family is presented.
2. Histologic changes in the mucous membrane of the respiratory tract—from the incipient nasal catarrh, followed successively by suppurative rhinitis, atrophic rhinitis, chronic granuloma to the final deforming scleromatous scar—are shown.

3 Of the various therapeutic measures tried streptomycin in an adequate dose is the most promising

4 A diagnosis of scleroma can be made by trained bacteriologists and serologists long before histologic changes are recognized (Author's Summary)

Bell's Palsy Pathology and Surgery A Report concerning fifty patients who were operated on after the method of Ballance and Ducloux KARSTEN KETTEL, M D (Hillerød, Denmark) *Arch Otolaryng*, 1947, xlvI, 427-472

The author sets out to estimate the value of the operation and to try to arrive at a deeper understanding of the pathology

Changes which have not been described earlier have been demonstrated both in the mastoid cells, and in the facial canal itself

Ætiology and Pathogenesis

Much seems to indicate that Bell's palsy is a pathogenetic entity, the primary and central feature of which is a 'dysregulation' of the circulation, which probably takes place near the stylomastoid foramen. In most cases the nerve as the most susceptible tissue suffers alone, in other cases the surrounding, more resistant bone is also affected. The result is ischæmic paralysis and ischæmic bony necrosis respectively. The consequence of the lack of blood supply of the nerve is oedema with subsequent degenerative changes. The nerve is thus compressed in its bony canal which causes further impairment of the vascular supply, so that a vicious circle arises the process being reversible. Thus the actual cause of the paralysis is the ischæmia, the compression in the fallopian canal is only a secondary phenomenon and not as maintained by most authors the real cause of the paralysis. In extreme cases ischæmic necrosis of the nerve may be the result.

Surgical Therapy

In 85 to 90 per cent of the cases Bell's paresis subsides under suitable conservative treatment. In selecting the last 10 to 15 per cent of the patients Anglo American authors rely on the faradic reaction, maintaining that if the response becomes negative the patient will not recover at all or will only recover partly if conservative treatment is instituted. It is shown that this does not hold true, and the explanation is that the faradic stimulus is of too short duration to excite contractions of the musculature the chronaxia of which has become extended.

Fifty cases have been treated surgically on the basis of the following three indications —

1 A decompression should be done in cases in which signs of beginning mobility have not appeared after an observation period of two months.

Indication (1) ought to be considered as serving temporarily until better means have been obtained for selecting the early cases for operation.

2 A decompression should be done if the spontaneous recovery of mobility has ceased before complete restitution has been obtained.

3 Decompression is indicated in relapsing paresis.

R B LUMSDEN

Abstracts

The Antihistaminic Drugs. GEORGE L. WALDBOTT, M.D. (Detroit). *Jour. A.M.A.*, September 27th, 1947, CXXXV, 4, 207.

The most promising of these drugs are antistin, neoantergan, pyribenzamine hydrochloride and benadryl hydrochloride. They inhibit secretion induced by histamine in the lacrimal and salivary glands and the mucous glands of the bronchial tree. They produce local anæsthesia when injected as well as when applied locally. They do not neutralize histamine chemically nor do they prevent its production in the body. They are believed to compete with histamine in its affinity for the cells. They are entirely palliative, since symptoms recur in four to six hours. There is no indication of a cumulative action or of addiction to the drug. In hay fever, they are most beneficial during the first part of the season when the nasal mucosa secretes clear, watery fluid and when there is no evidence of secondary infection. Waterlogged mucous membranes and nasal polyps shrink visibly within thirty minutes after ingestion of the drug. This is also true in perennial allergic rhinitis in the absence of suppurative changes.

Side effects, such as drowsiness, dizziness, headaches, nausea, dryness in the throat and muscular twitching may appear with the first dose and be absent later or vice versa.

The article has three figures, two tables and a bibliography.

ANGUS A. CAMPBELL.

Contributions to Aviation Otolaryngology

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E. D. DALZIEL DICKSON

and other members of the Royal Air Force
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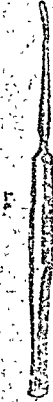
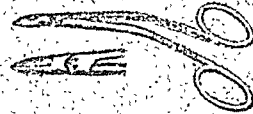
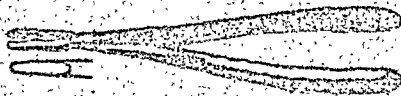
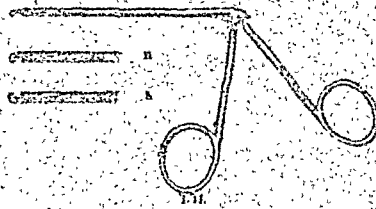
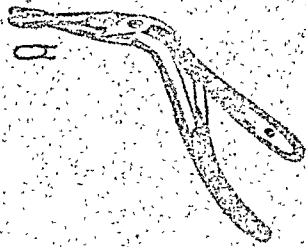
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A CASE OF OTITIC HYDROCEPHALUS

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CLINICAL NOTES—

SOUND CONDUCTION THROUGH THE STERNO
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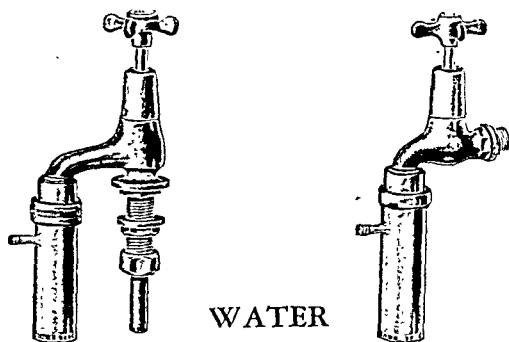
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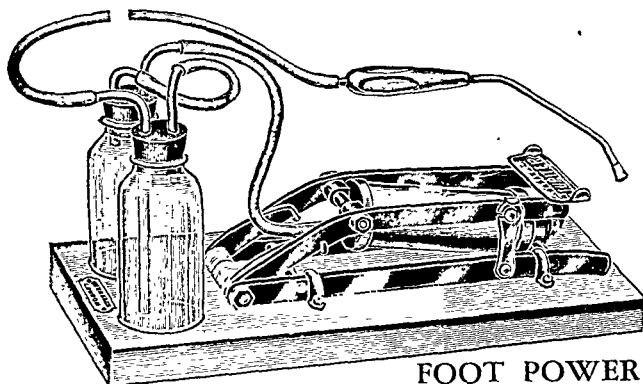
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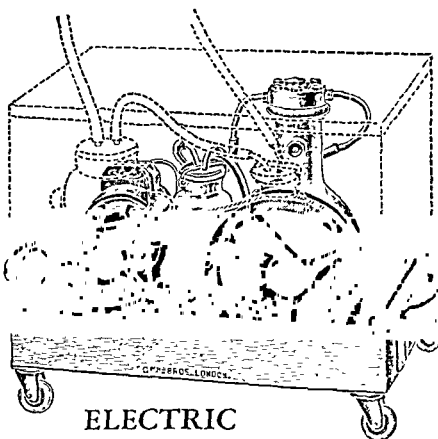
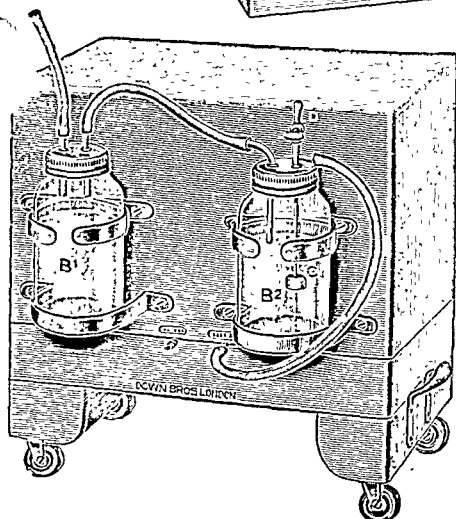
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June 1948

THE PHYLOGENY OF THE MAMMALIAN TYMPANIC CAVITY AND AUDITORY OSSICLES

By JOHN GERRIE (Aberdeen)

FEW problems in morphology have aroused more interest in the last hundred years than the evolution of the tympanic cavity and auditory ossicles. The subject has been approached along two avenues, from the paleontological aspect and from the ontogeny of present day animals, and although one or two minor points still require clarification, the main course pursued may now be regarded as finally settled.

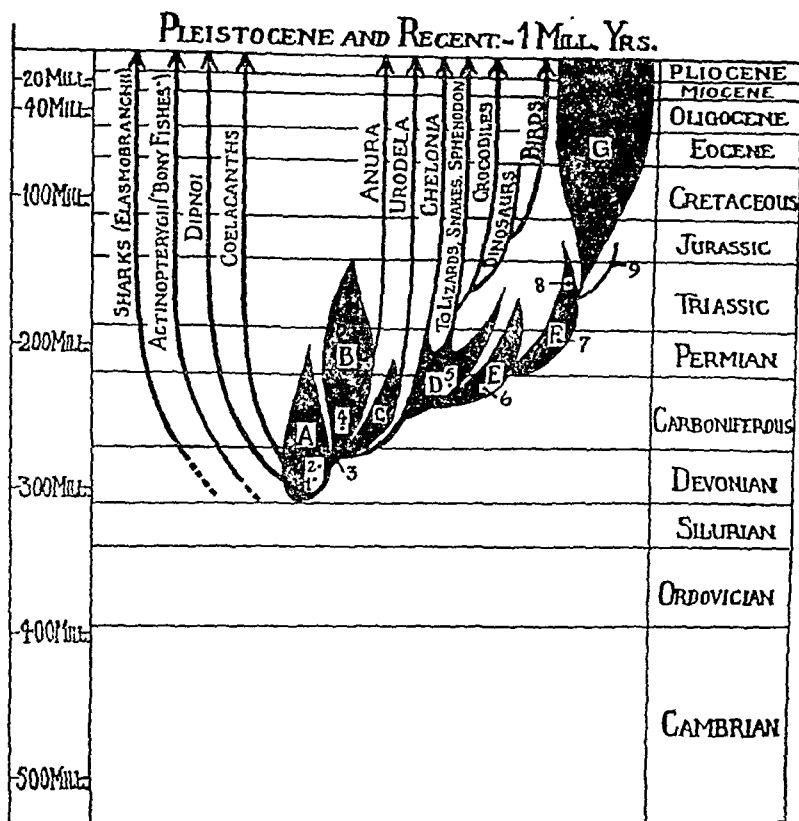
In reviewing the work which has been done on the evolution of the tympanic cavity and ear ossicles, Westoll has pointed out that much of our information as to the detailed homology of the ossicles has been obtained from adult and embryonic stages of living mammals and reptiles, whereas mammals have originated from the extinct Therapsid reptiles which are not closely related to the reptiles of the present day. In addition, Romer has stated that it is unwise to depend too much on conditions present in so called "primitive" living fishes, amphibians and reptiles, as these forms are often highly specialized and are therefore degenerate, and that more importance is to be attached to the form presented by more generalized fossil ancestors.

It will be well, therefore, to trace first the course of mammalian evolution through the ages, as it is understood at the present time (Fig. 1).

The origin of the first *primitive vertebrates* is still unknown. Various theories have been advanced, putting forward the claims of various invertebrate groups for this honour, but the question has never been satisfactorily settled. Thus, Patten holds the view that the vertebrates

John Gerrie

were derived from the arachnid stem, but the objections to this view, according to other observers, are formidable. As Gregory has said, the real ancestors of vertebrates are either still hidden in unexplored rock of



- A. Rhipidistia.
- B. Labyrinthodonts.
- C. Microsauria.
- D. Cotylosaurs.
- E. Pelycosaurs.
- F. Therapsids.
- G. Mammals.

- 1. Osteolepis.
- 2. Eusthenopteron.
- 3. Ichthyostega, etc.
- 4. Eogyrinus, etc.
- 5. Captorhinus.
- 6. Dimetrodon.
- 7. Gorgonopsia, Therocephalia, etc.
- 8. Cynodonts.
- 9. Tritylodon and Ictidosauria.

FIG. 1.

The descent of the mammals.

pre-Silurian ages, or have been wiped out for ever by the destructive forces of erosion.

The first vertebrates were undoubtedly marine and agnathous (jawless), and were probably like the cyclostomes (lamprey, hagfish), of the present day. Although fossil remains of these first vertebrates are found in the Ordovician system (about 400 million years old), it is only in the

Mammalian Tympanic Cavity and Auditory Ossicles

Devonian period, some hundred million years later, that *fishes* were first found in abundance. Towards the end of the Devonian period, about 280 million years ago, the most important theatres of evolution of bony fishes were continental bodies of water, rivers and lakes, which were not very stable because of climatic conditions, and because the earth's crust in these regions was being warped and distorted in the aftermath of one of those great "earth-storms" which result in the production of vast mountain ranges. The development of land vegetation during the Devonian and Carboniferous periods culminated in the growth of vast forests on the swampy surfaces of vast tracts of sand and silt brought down by streams from these Caledonian mountain chains, these swamp forests are the source of our most important coal seams. In such unstable conditions, it was a great selective advantage to any vertebrate to be able to withstand drying-up of its home waters. Few of the multitudinous variety of fishes present at that time could have survived this ordeal, and there would appear to be only two groups which could have claims to the honour of standing nearest the main evolutionary line. These are, the lung fishes or Dipnoi, and the Crossopterygian fishes (e.g. *Osteolepis*, *Eusthenopteron*). Both groups had a lung in addition to gills, and this allowed them to breathe atmospheric air when the streams and swamps became dry. In addition, the present-day descendant of the Dipnoi, the lungfish (*Epiceratodus*) of Australia, in its embryonic development, closely parallels certain living salamanders, while *Latimeria*, the only living Crossopterygian, in some ways resembles both the lung fishes and amphibia. The Crossopterygians and early Dipnoi had, like most fishes, pectoral and pelvic fins essentially homologous with the paired limbs of higher vertebrates, but the structure of the limb skeletons is sufficient to show that these two groups must include the only possible ancestors of the higher vertebrates. Recent work appears to narrow the choice still further to one group, the Rhipidistia, of the Crossopterygii, although Gregory believes that all known members of the group were too late in time and too specialized to be ancestral to land vertebrates, this is not necessarily the case, and he accepts the view, held also by Romer and Westoll and most paleontologists, that the Crossopterygians were on or very near the "main line" of descent.

It would seem that the *amphibia* were originally a fish group, probably Crossopterygian, which had developed terrestrial locomotion in response to external environment in the Devonian period. However, their early history is poorly known, and the material available for investigation consists only of a few skulls of primitive ichthyostegid amphibians from Greenland, and a skull roof (*Elpistostege*) from Scaumenac Bay, Canada the latter being either from a fish-like amphibian or an amphibian-like fish. Watson, in his study of the later amphibians, has thrown a good deal of light on earlier conditions. The Carboniferous period, 250 million

years ago, is the time of greatest development in the amphibians, and a large number of types developed. The Ichthyostegids are rare finds in the late Devonian and in the Carboniferous, but the labyrinthodonts are common, and towards the close of the period amphibians with definite reptilian characteristics appear, such as *Diplovertebron*, and relatives of *Seymouria*.

Seymouria was long regarded as an almost perfect "missing link" between the amphibia and reptiles; while this is not so generally accepted now, it is true that in the late Carboniferous we have fossil remains of two or three groups of reptiles, which have so much in common with the Carboniferous amphibia that descent from them is certain. However, the details of the rise of the various reptile groups in the later Carboniferous and Permian periods, say 250 to 200 million years ago, are still very shadowy.

With the *reptiles* came a great advance, as eggs were laid on land, and with this the possibility of higher forms of life, including man, appeared. The earliest reptiles, the Cotylosaurs, were in the main herbivorous, but the most prominent of early reptiles, the Pelycosaurs, were carnivorous, and their descendants, the Therapsids, or mammal-like reptiles, ultimately replaced them to become the ruling order during the Permian and Triassic periods.

During the Mesozoic era, or Age of Reptiles, from 190 to 60 or 70 million years ago, the great reptilian groups, now extinct, roamed the earth and soon broke up into many orders, including the turtles, lizards, snakes, crocodiles, dinosaurs, flying reptiles, and birds. During this era, birds and mammals both descended from reptiles, made their appearance. There seems to be no doubt, however, that mammals, in spite of their obvious advantages of controlled body temperature, better locomotion, and reproductive methods, were very much in the minority as very few mammalian remains have been found in Mesozoic rocks, and these are from widely scattered parts of the globe.

It would seem that the earliest *mammals* of the Mesozoic were insectivorous, and no larger than mice, but towards the close of the era they may have approached the size of beavers, and in some quarters it is believed that the duck-billed platypus of Australia, the marsupials, and the North American opossum are related to these mammals of the age of reptiles.

The primates first appeared in the Eocene period about 60 million years ago, and from anatomical and paleontological evidence it is assumed that they went through an arboreal stage, some of them later coming down to the ground. Fossils, however, of tree shrews, lemurs, tarsiods, monkeys, apes and man are extremely rare, and usually amount to fragments of jaws and teeth, but they are exceedingly valuable when they are found, as they indicate the changes in structure which have taken place. According to most workers, in particular Keith, man still bears the

Mammalian Tympanic Cavity and Auditory Ossicles

indelible stamp of the tree-living habits of his remote primate ancestors, and of the adaptations which have taken place to enable him to pursue bipedal progression on the ground. It is still uncertain when human characters began to take shape among the advanced primates. Osborne believes that separation of man and the apes from the primitive anthropoid stock took place some 35 million years ago, but Gregory considers the event to have been much later, probably about 19 million years ago.

The Mammalian Middle Ear (Fig. 2)

In considering the phylogeny of the tympanic cavity and ossicles, certain points in the anatomy of the mammalian (e.g. human) middle ear are of importance. Although the outer wall of the cavity is formed principally by the tympanum, there are two extensions, the epi-tympanum and hypo-tympanum, the former being the more important from the evolutionary viewpoint. The tympanum is attached to a groove in the

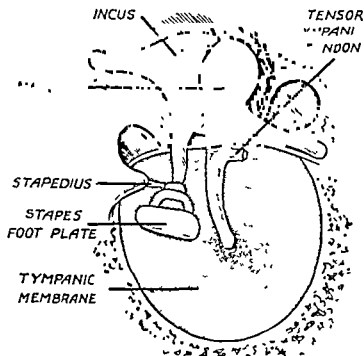


FIG 2

Diagrammatic representation of the middle ear in mammals (Beatty, R T — *Hearing in Man and Animals*, London, 1932)

tympanic bone, which is open above at the notch of Rivinus, and from the two ends the anterior and posterior malleolar folds pass to the short process of the malleus. Shrapnell's membrane, or pars flaccida, is of different texture to the pars tensa, as it contains no middle fibrous layer. There are three ossicles, the malleus, incus, and stapes, forming a chain between the tympanum and the oval window. The malleus consists of a head, lying in the attic, a handle inserted into the fibrous layer of the tympanum, a short process, and an anterior process, the processus

gracilis or folii, a long slender spine of bone which passes to the glaserian fissure. The incus articulates by its "crown" with the head of the malleus and by its long process with the summit of the curve of the stapes. The footplate of the stapes lies in the oval window. The stapedius muscle emerges from the pyramid to its attachment on the stapes, and the tensor tympani passes from the anterior wall above the eustachian orifice to its attachment on the malleus. In mammals two small cartilages are occasionally found in relation to the middle ear, Paauw's cartilage in the stapedius tendon, and Spence's cartilage in the neighbourhood of the posterior malleolar fold.

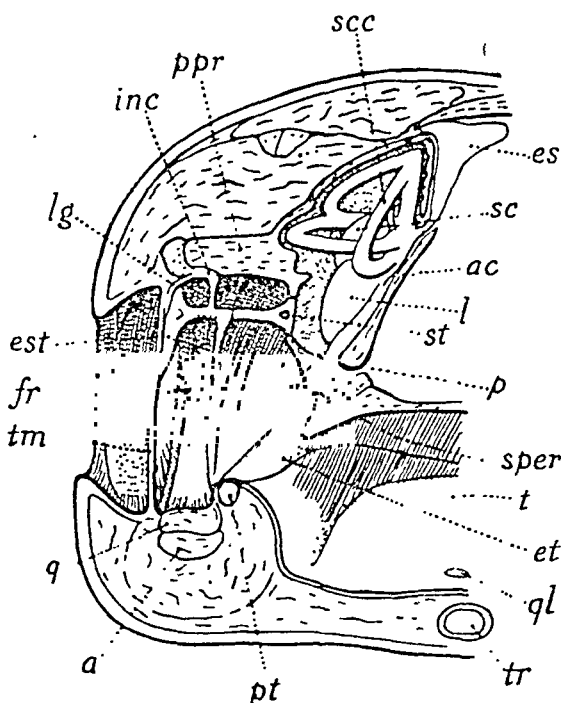


FIG. 3.

Left half of head of *Lacertilian* cut transversely through tympanic cavity and seen from behind. (a) Articular; (ac) inner wall of auditory capsule; (est) extra-stapedial cartilage; (et) Eustachian tube; (fr) fenestra rotunda; (q) quadrate; (inc) intercalary, end of dorsal process; (st) stapes; (tm) tympanic membrane. (Goodrich, 1930, after Versluys.)

The Middle Ear in Reptiles and Amphibians (Fig. 3)

A tympanic cavity is exhibited by all living reptiles with the exception of snakes. The amphibians, however, are highly specialized, and in many cases so degenerate that only the terrestrial anura have a tympanic cavity. In neither the reptiles or amphibians is there a malleus or incus, but simply a bony or cartilaginous rod, the columella, running between the oval window and tympanum. In amphibia, especially those with

Mammalian Tympanic Cavity and Auditory Ossicles

burrowing habits or an aquatic existence, the columella is often incomplete. In the case of reptiles, it is quite well defined, being in two parts, the proximal portion or otostapes at the oval window, and the distal portion or extra-stapes abutting the tympanum. The extra-stapes exhibits two processes, the processus quadratus passing downwards and forwards in the roof of the tympanic cavity, and the processus dorsalis which dwindles to a ligament in the adult, leaving only the upper end, as the intercalary of Versluys, lying between the quadrate bone and the crista parotica of the auditory capsule.

It will be seen, therefore, that important differences are present in mammals as compared with amphibians and reptiles. Whereas mammals present three ossicles in the middle ear, the malleus developed from Meckel's cartilage, the incus from the quadrate, and the stapes developed from the hyoid arch, amphibians and reptiles present only a columella developed from the hyoid arch.

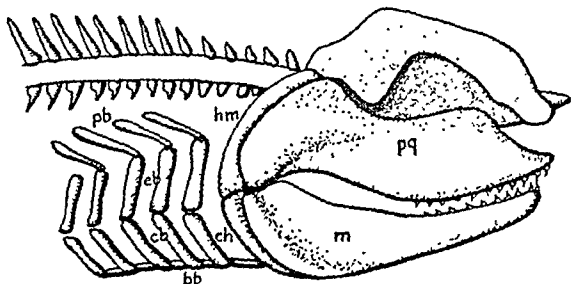


FIG 4

The jaws and branchial arch system of a shark, essentially the Mesozoic *Hybodus* (*hm*) hyomandibular, (*pq*) palato-quadrates, (*m*) mandible. (Romer, 1945)

The Condition in Fishes (Fig. 4)

Fishes, being dependent on underwater vibration for sound perception, do not possess, and indeed do not require a middle ear. However, from the brain case in the region of the otic capsule to the jaw joint on either side is a structure, the hyomandibular, developed from the hyoid arch, and used in higher fishes for bracing the jaws against the skull in mastication. This structure, on ontogenic grounds alone, can be considered homologous with the amphibian and reptilian columella and the mammalian stapes.

It will be seen, therefore, that mammals differ from all the lower Gnathostomes in that they have introduced into their tympanic cavity

two bones, the malleus and incus, which are not present in the middle ears of present-day amphibians and reptiles. In addition, it is a fact that all mammals have a simple lower jaw, composed of a single dermal bone, the dentary, articulating with another dermal bone, the squamosal, fixed to the skull. These two characteristics are intimately related. In all the Gnathostomes, with the exception of the mammals, the jaw articulation lies between the quadrate region of the palatoquadrate above and the articular region of Meckel's cartilage below. In all above the Chondrichthyes (cartilaginous fishes) the articulation is formed by separate quadrate and articular cartilages or bones.

Many different views as to the homology of the auditory ossicles have held the day, but there can be no doubt now that the Reichert-Gaupp theory is essentially correct. According to this theory, the mammalian stapes is derived from the reptilian columella, the incus from the quadrate and the malleus from the articular, the dentary having acquired a new articulation with the squamosal, and the question is, how could such a radical change in the articulation have come about without interrupting the proper function of the jaws?

It is one of the triumphs of a long series of researches on the extinct fishes, amphibians and reptiles of the main evolutionary line, begun by Owen in 1845 and continued by Seeley, Broom, Watson, Suskin, Olsen and Parrington and Westoll, to have shown the intermediate steps by which the change occurred, whereby the jaw articulation changed from an inner quadrate to an outer squamosal, with the quadrate and articular ending up in the tympanic cavity.

Early Vertebrates

The earliest vertebrates were undoubtedly jawless (agnathous), and the visceral arches, similar throughout, probably formed a series in the branchial region. Later, it is assumed that each visceral arch became divided into two or more parts, each part lying at an angle with its neighbour, and that in land-vertebrates great reduction took place in the whole system.

The upper part of the mandibular arch forms the upper jaw or palatoquadrate, while its lower part forms the mandible. The cartilaginous bar of the lower jaw is known as Meckel's cartilage. The nerve is the Vth nerve. The next arch is the hyoid arch, and its cartilage is Reichert's cartilage, and the nerve is the VIIth nerve. In most primitive jawed vertebrates, for example the fossil placoderm fishes, the gill-slit lying directly behind the jaws is elongate, and comparable in size with those succeeding it, but in most fishes the jaws have enlarged so much that they have encroached on the hyoid arch to such an extent that the gill-slit has been reduced to a mere chink, the spiracle. This having occurred, the upper part of the hyoid arch, or as it is now termed, the hyomandibular,

Mammalian Tympanic Cavity and Auditory Ossicles

assumes a new function, bracing the jaws against the skull in mastication (Fig. 5).

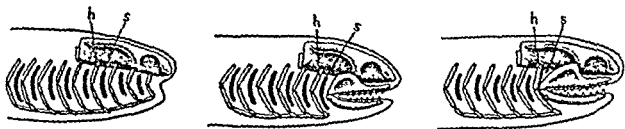


FIG 5

structures in vertebrates. Left, the agnathous type, stage seen in the Placodermi, one or two anterior one of the anterior gill bars, gill slit behind jaws (h) immediately behind unspecialized Right

Condition in fishes above Placoderm level, upper part of hyoid arch now forms the hyomandibular, reducing gill slit to form the spracle (s) (Romer, 1945.)

Early Fishes

One group of early fossil fishes, the Crossopterygii, living in the Devonian period, as we have seen above, is ancestral to ourselves. In the suborder Rhipidisia, there are two fishes, *Eusthenopteron* and *Ectosteorhachis*, in which the hyomandibular has been closely studied.

In *Eusthenopteron*, the jaw joint is formed by the quadrate lying at the back of the palato-quadrate and the articular which is an ossification in Meckel's cartilage. The hyomandibular lies immediately behind the palato-quadrate, running downwards from the brain case to the jaw articulation. It is pierced by the main hyomandibular trunk of the VIIth nerve. There are five attachments to the surrounding structures—two proximal attachments, the processus ventralis to the wall of the otic capsule in the sacculolagenar region, and the processus dorsalis reaching almost to the dermal skull roof, the processus opercularis, extending to the bony operculum or gill-cover; the processus quadratus to the quadrate bone, and the processus hyoideus to the hyal region.

In the osteolepid condition the mandibular arch, the hyoid arch, and the first branchial arch are so crowded together that there is no possibility of a tympanic diverticulum of any size having developed from the pharynx.

Primitive Amphibia

Although the material available of the head region of primitive amphibia is poor, there seems to be no doubt that, as compared with the condition in fishes, separation of the branchial arches did occur, with forward movement of the quadrate and backward movement of the hyoid region of the first arch, the homologue of the hyomandibular remaining stationary. This is evident on comparing the skulls of a lobe-finned fish such as *Eusthenopteron* with that of fairly primitive amphibia (Fig. 6). In the amphibian skull, there is no longer a series of interlinked bony

plates in the opercular region, as was seen in the fish, and instead, there is a notch present, the otic notch, which in all probability bore a tympanum. The otic notch in the amphibians is placed high on the skull. This change is believed to have been synchronous with the start of head movements and the development of the neck joint with its musculature.

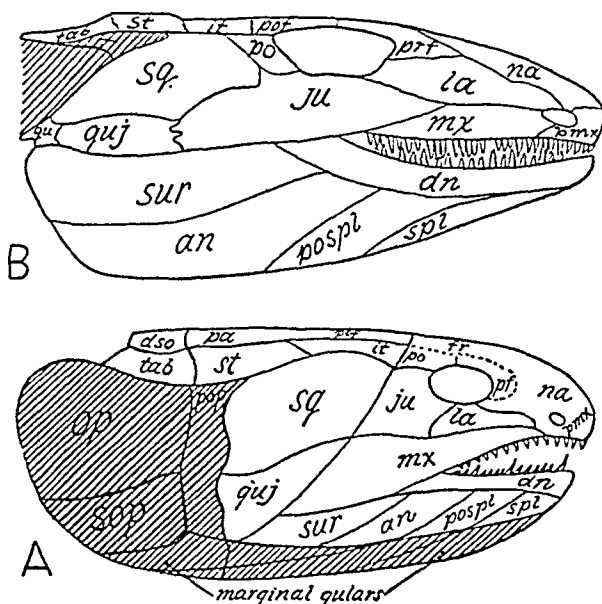


FIG. 6.

A. Head region of primitive fish showing dermal bones (shaded) in opercular region.
 B. Head region of primitive amphibian showing absence of bones in opercular region, formation of otic notch (shaded). (Gregory, W. K.—*Our Face from Fish to Man*, New York, 1929.)

In all primitive amphibians the hyomandibular has given place to a columella, running from the fenestra ovalis to the otic notch with its membrane. The extra-columella, or processus tympanicus, abutting the tympanic membrane, is apparently homologous with the processus opercularis of the Crossopterygian hyomandibular, as the morphological relationships to surrounding structures are identical. The stegocephalian columella (Fig. 7a) has four other attachments, the processus ventralis to the pseudo-fenestra ovalis, the processus dorsalis to the tabular, the processus quadratus, probably connected by a ligament to a roughened tubercle on the quadrate, and it is probable that a branch of this ligament passed to the ceratohyal (processus hyoideus).

The extent of the tympanic diverticulum of the pharynx can be outlined in some specimens. Thus, in *Benthosuchus* (Bystrow and Efremov, 1940, also Westoll, 1943) the relief of the pterygoid region and otic notch allow almost complete certainty. The ligamentous connections to the

Mammalian Tympanic Cavity and Auditory Ossicles

quadrate and hyoid were probably as have been described, and the eustachian tube passed through the level of the bony palate just lateral to the posterior end of the suture between the pterygoid and the parasphenoid. The tympanic diverticulum occupied an "excavatio tympanica" formed by the pterygoid and exoccipital, while the antero-medial support of the tympanum seems to have been on the tabular and squamosal.

It has been suggested by Westoll that there are two spaces which could have accommodated a pharyngeal diverticulum in the primitive amphibia—one just above the processus quadratus and the other just behind the angle of the jaw between the processus quadratus and the processus hyoideus.

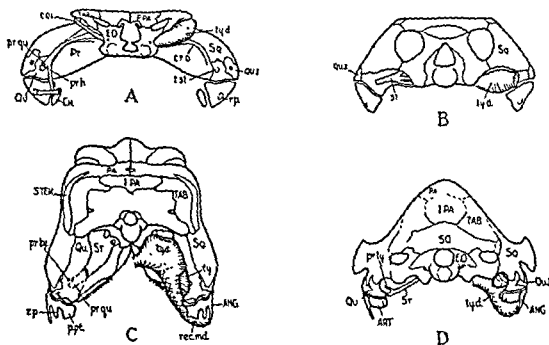


FIG 7.

(pr qu.) processus quadratus, (pr ty) processus tympanicus, (qu) quadrate. (Qu J) quadratojugal, (rec md) recessus mandibularis, (st.) stapes, (tab) tabular, (ty d.) tympanic diverticulum (Westoll, 1943)

Primitive Reptilia

In a primitive reptile, such as the *Cotylosaur*, *Captorhinus* (Fig. 7b) two changes are to be noted compared with the primitive amphibian condition. First, because of the down-turning of the par-occipital process and tabular, there is a change in direction on the part of the columella and eustachian tube from postero-dorso-laterally to postero-laterally and as the quadrates take on a forward position, the direction is then almost lateral. Second, and also because of this down-turning, the tympanic diverticulum which may have been present above the processus

quadratus would have become compressed. It was noted above, however, that a second diverticulum may have been present, in which case it is probable that this latter diverticulum, lying between the processus quadratus and processus hyoideus, reached up to surround the processus tympanicus and processus quadratus of the columella to meet the dorsal diverticulum. This, of course, is seen in the ontogeny of present-day lizards, which are descended from primitive reptiles.

The columella, with this change in direction, has a different appearance in primitive reptilia as compared with primitive amphibia. Although

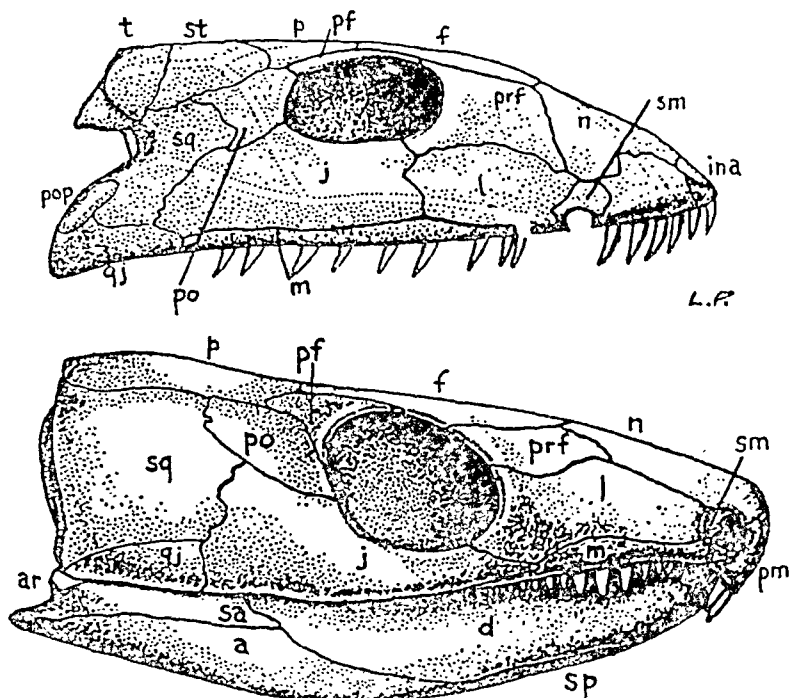


FIG. 8.

UPPER FIGURE. Lateral view of skull of *Ichthyostega* showing otic notch.

LOWER FIGURE. Lateral view of skull of *Captorhinus* showing absence of otic notch (Romer, 1945).

the main external relationship is obviously with the quadrate, the outer end of the bone is not usually well preserved, so that there may have been an extra-stapedial connection with the tympanum, as described by Broom in Therapsids. In addition there has been obliteration of the otic notch on the head due to the downward drag of the tabular and par-occipital plate (Fig. 8). Therefore, although the bone may look altogether different, the relationships are the same, and the homology is maintained. In present-day lizards similar conditions prevail, and all five processes are represented.

Mammalian Tympanic Cavity and Auditory Ossicles

In all forms, the main hyomandibular trunk of the VIIth nerve still emerges from the cranial cavity just in front of the articulation of the columella, passes back between the two heads, then downwards and outwards, dividing into the hyoid branch which runs along the ceratohyal, and the chorda tympani. The mental branch would only be preserved in those tetrapods with functional latero-sensory organs.

Mammal-like Reptiles—Pelycosaurs and Therapsids (Fig. 7c and d)

It would seem probable, in the evolution of the mammal-like reptiles, that an extension of the existing tympanic cavity, a recessus mandibularis, took place towards the lower part of the angular in the lower jaw and ultimately became housed in the reflected lamina of that bone (Fig. 9),

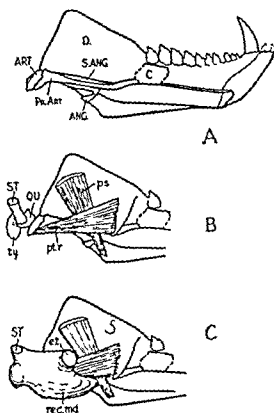


Fig. 9

Suggested relations of the tympanic diverticulum in cynodont reptiles

A Inner view of left mandible of *Cynognathus*

B Same with addition of quadrate, stapes, tympanic membrane, and the reptilian pterygoideus muscle and pseudo-temporal muscle

C Same with addition of tympanic cavity showing processus ventralis of stapes (at fenestra ovalis), eustachian tube, and recessus mandibularis housed in angular notch

(ANG) angular, (ART) articular, (C) coronoid, (D) dentary, (et) eustachian tube, (Pr. Art.) pre articular, (ps.) reptilian pseudo-temporal muscle (pt r) reptilian pterygoideus muscle, (Qu.) quadrate, (rec md) recessus mandibularis, (ST) stapes, (ty) tympanum, (S ANG) surangular (Westoll, 1943.)

and it is also possible that this low extension may have been correlated with the descent of the roof of the tympanic cavity in reptiles. It also brings the tympanic cavity into direct relationship with the small bones in the neighbourhood of the jaw articulation, so soon as the old joint

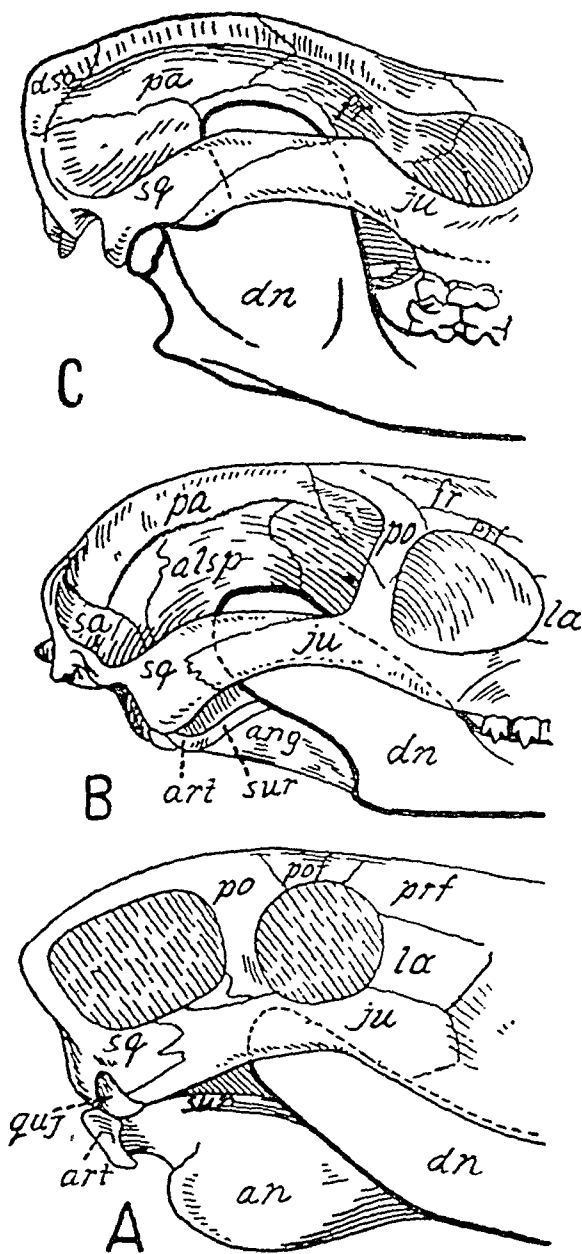


FIG 12.

A Primitive mammal-like reptile

B Advanced mammal-like reptile.

C Primitive mammal, showing progressive up-growth of the dentary bone to form a new joint with the skull.

Mammalian Tympanic Cavity and Auditory Ossicles

In mammals, the more lateral dentary-squamosal joint is now functional, allowing the tympanic diverticulum to envelop the small bones at the posterior end of the lower jaw, and those originally in the reptilian jaw articulation. Thus, the quadrate becomes the incus, and the articular the malleus. The manubrium of the malleus, embedded

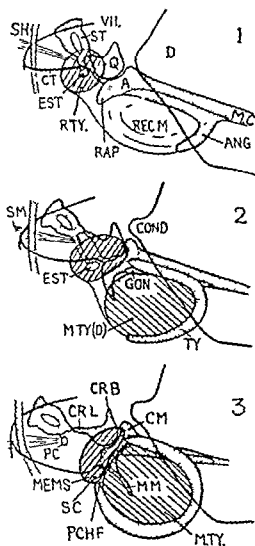


FIG 13

Three suggested stages (diagrammatic) in the evolution of the mammalian middle ear from an advanced theriodont (a cynodont) (A) articular, (ANG) angular, (C M) caput mallei, (COND.) condyle of dentary, (C R B) crus brevis, (C R L) crus longus (C T) chorda tympani, (D.) dentary, (E S T) distal part of extrastapes, (G O N) gonial, (M C) Meckel's cartilage, (M E M S) membrana Shrapnellii, (M M) manubrium mallei, (M T Y) mammalian tympanum, (M T Y (D)) developing mammalian tympanum, (P C) Paauw's cartilage, (P C H F) posterior "chordafalte", (Q) quadrate (incus of mammals), (R A P) retro-articular process, (R E C M) recessus mandibularis, (R T Y) reptilian tympanum, (S C) Spence's cartilage, (S H) stylohyal, (S M) stapedial muscle, (S T) stapes, (T Y) tympanic bone, (V I I) facial nerve (Westoll, 1945)

in the tympanum, is believed to be formed from the retro-articular process of the articular by the shifting forwards and downwards of the tympanum. Gaupp stated, in his masterly work on Reichert's theory, that the dermal portion of the processus gracilis or Folii of the malleus (the goniale)

was derived from the pre-articular, but recent work by Olson would seem to suggest that it comes from the corpus of the angular. Various views have been expressed as to the exact function of the reflected lamina on the angular, but the matter would now seem to be settled following the work of Palmer on the jaws of *Perameles*, which shows that it is homologous with the tympanic annulus of mammals (Fig. 14).

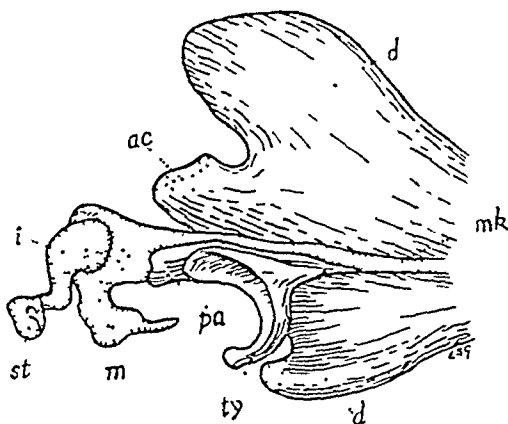


FIG 14

Diagram of inner aspect of posterior end of left mandible and auditory ossicles of a pouch young of *Didelphys aurita*. Cartilage dotted. (*ac*) Secondary cartilage on condyle, (*d*) dentary; (*i*) incus; (*m*) malleus; (*mk*) Meckel's cartilage, (*pa*) prearticular (anterior process of malleus), (*st*) stapes, (*ty*) tympanic. (Goodrich, 1930)

It is possible that two small elements found in the middle ear of various mammals, including man, the cartilage of Paauw in the stapedius tendon and the cartilage of Spence in the region of the posterior malleolar fold (the posterior chordafalten of Bondy) are remains of the reptilian extra-stapes.

This work on the auditory ossicles has been fully substantiated by work done on the jaws of embryonic and foetal mammals.

I wish to express my indebtedness to Dr. T. S. Westoll of the Department of Geology and Mineralogy, University of Aberdeen, for his great kindness and helpful co-operation in the preparation of this article.

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AURAL TRAUMA CAUSED BY GUNFIRE

REPORT ON A CLINICAL INVESTIGATION OF 108 SOLDIERS EXPOSED TO GUNFIRE WHO, ON SOME OCCASION, HAD COMPLAINED OF INJURY TO THEIR EARS*

By MAJOR E. G. COLLINS, R.A.M.C.

Introduction

The subject of injury to the ears caused by gun-fire was brought to the notice of Brigadier F. A. E. Crew, Director of Biological Research who co-operated with Brigadier M. L. Formby, Consultant Oto-Rhino-Laryngologist, and Dr. C. S. Hallpike of the Medical Research Council to investigate the problem. This report is consequently concerned only with one part of a much wider field of investigation. The work which is recorded here was carried out during the months of August and September 1943, by Major E. G. Collins, Royal Army Medical Corps at the National Hospital, Queen's Square.

Purposes of the Investigation

1. To determine the degree of hearing loss which may be caused by gunfire as shown by the pure tone audiometer and the whispered voice.
2. To diagnose the type of aural lesion present.
3. To estimate the effect of any hearing loss present on the efficiency of the soldier.
4. To explore the possibility of any common contributory factor and to evaluate the effects of a variety of factors which are likely to be contributory.
5. To determine whether gunfire has any effect on the vestibular labyrinth.
6. To correlate subjective symptoms and signs with the results of clinical examination.
7. To estimate the beneficial effect on the hearing of any local protection which may have been used.

Material

The names of the 108 soldiers examined were taken from a War Office list especially compiled by Brigadier Formby for the purpose. Selection

* This report was presented to the War Office in November, 1943, but publication has been deferred.

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was exercised in order to give a cross section of the effects on the ears of the various weapons employed in the Army. In addition, an attempt was made to exclude men with chronic suppurative otitis media as it was felt their inclusion might confuse the issue. In actual fact, it was found that the information then available was not adequate and it has been necessary to form a separate group of 25 miscellaneous cases. This includes patients who, on examination, showed evidence of chronic suppurative otitis media and others, whose injuries arose under such special circumstances as made it desirable to exclude them from the main group. The analysis which follows therefore concerns 83 men only, the majority of whom had not served outside the British Isles.

Analysis of Results

(83 men)

In this analysis, the results are summarized under the divisions of (1) Auditory Function, (2) Labyrinthine Function.

Auditory Function

Before presenting the tabular analysis some explanatory statements are necessary.

Methods and Conditions of Examination

(1) *Inspection of the Ear, Nose and Throat*

In addition to inspection of the tympanic membranes with the forehead mirror and Siegle's speculum, an electric otoscope (Zeiss magnification 9×2) was employed and the effect of auto-inflation of the eustachian tubes was observed with this. A thorough examination of the pharynx, nasopharynx and nose was made.

(2) *Hearing Tests*

These comprised tuning fork tests, and test of hearing of the watch, conversational voice, whispered voice and pure tone audiometer.

(a) *Tuning Fork Tests.* The tuning fork used was C 512 but the result of the standard tests (Rinne, Weber and Schwabach) were frequently checked with C 256. No appreciable variations were found between the results obtained with the two forks. Both forks were of the Gardiner-Hill type. In the case of a patient having a negative Rinne test, "masking" of the ear not under test was carried out by a "Sh" noise of moderate intensity applied by an assistant through a speaking tube of the deaf-aid variety. The bone conduction recorded was the absolute bone conduction of the patient tested against that of the examiner and recorded by stop watch. The examiner's bone conduction is normal.

(b) *Watch and Conversation Voice Tests.* The normal distance for the hearing of the watch was 36 inches. At times, owing to background

noise, this was reduced to 24 inches, but in such circumstances the reduction has been recorded. The normal distance for the conversational voice was not ascertained, but it was greater than 30 feet.

(c) *The Whisper Test.* Considerable emphasis is laid upon this test since it constitutes the basis for Army tests of auditory efficiency. Nature has provided such a reserve of hearing that deafness in one ear does not impair the efficiency of a soldier to a great extent owing to the compensatory action of the good ear, though of course it represents what is usually a pathological lesion. Unfortunately, in these patients both ears were frequently affected, though usually one ear suffered greater damage than the other. It is felt that this fact should be shown in the summary. One of the standard Army tests for recording the hearing in both ears is for the patient to sit with his back to the examiner and to listen to a forced whisper at 10 feet. This method is open to the criticisms that it gives little indication of the true clinical condition and that the conditions laid down in the test seldom occur in actual practice. In the analysis which follows, it has consequently been decided to record :—

- (1) The hearing for the whispered voice with the worse ear, which gives an indication of the severity of the lesion.
- (2) The hearing for the whispered voice in the better hearing ear which gives an indication of the impairment in military efficiency.

The tests were carried out in a large basement room, which was not, however, entirely free from background noise inseparable from London traffic. All the tests were applied by myself using an intensity of whisper to which I am accustomed. It is not a forced whisper, nor is it delivered in full expiration as is often prescribed. With full hearing acuity it is heard at 30 feet, but since it is considered desirable to exclude from consideration all hearing losses of doubtful degree when assessing military efficiency, the distance standard for normal hearing has been reduced to the easy figure of 20 feet. For the present test two-digit numbers were mainly used—a practice which facilitates standardization of whisper intensity. The duration and high phonetic power of the vowel sounds of numbers give them a high audibility and furthermore their use greatly narrows the range of anticipation which the subject is called upon to exercise. It is clear that this kind of test would be of little value in the recognition of small defects. The latter are demonstrated by the pure tone audiometer.

(d) *Audiometer Test.* The audiometer used was the Western Electric 6A, which was accurate as regards intensities, but which had a slight variability as regards some of the frequencies. The test was carried out in a sound-proof room. All tests were carried out by a single experienced tester following a standard test procedure. Air conduction audiometric tests only were made. After due consideration, it was decided that

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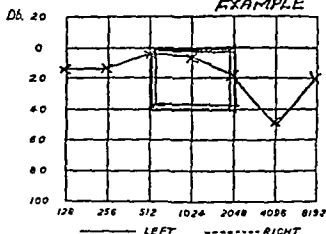
audiometric bone conduction tests were not sufficiently reliable to use as a routine procedure unless great care was taken to "mask" the ear not under test and even then the instrumental error would be considerable. In the analysis which follows, it is proposed to adopt three standards of hearing loss for general comparison.

Normal Hearing. Any decibel loss of 0-20 over each or all of the frequencies has been regarded as normal. This makes allowance for the personal factor and any instrumental error which may be present.

The standards of hearing loss adopted are :—

STANDARD I

EXAMPLE

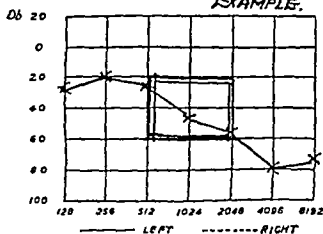


Standard I

An average loss over the speech frequencies not exceeding 20 decibels (C 512, 1024 and 2048) + a decibel loss at frequencies 4096 and 8192 which exceeds 30 (i.e. high tone loss only).

STANDARD II

EXAMPLE.

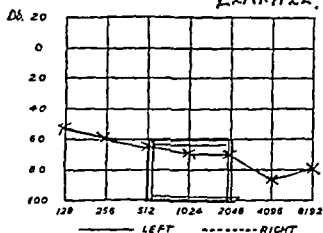


Standard II

An average loss over the speech frequencies (C 512, 1024 and 2048) of 21-60 decibels + a decibel loss at frequencies 4096 and 8192 which exceeds 30 decibels.

STANDARD III

EXAMPLE.



Standard III

An average loss over the speech frequencies (C 512, 1024 and 4096) exceeding 60 decibels + a decibel loss over frequencies 4096 and 8192, which exceeds 60.

Such diversities are met with over frequencies 4096 and 8192 that it is impossible to analyse them further, but the effect of this loss on hearing for speech is small, except for some of the sibilants. In the following summary, the standard for the worse ear only will be shown. The greater decibel loss was usually recorded by the ear claimed by the patient to have sustained the more severe damage.

(e) *Type of Deafness.* This has been deduced from the study of all the relevant facts in each individual case. In general, the criteria for diagnosing a nerve deafness have been a positive Rinne, decibel loss over the high frequencies, and decreased bone conduction, though occasionally the last sign may be absent. It is often difficult or impossible to decide in a case of "mixed" deafness how much the patient's loss of hearing is due to a nerve lesion and how much to a middle-ear condition.

It is of some interest to note that in the analysis of returns submitted to the War Office of patients who had complained of injury to their ears due to gunfire, 48·6 per cent. were among the Anti-Aircraft Artillery, 26·1 per cent. among Field Artillery, 18·4 per cent. among the Infantry and 6·9 per cent. Coast Defence personnel. These percentages will obviously vary from time to time with the strengths of the various commands maintained in the United Kingdom and with the varying amounts of gunfire to which the patients are exposed.

Conclusions

1. In 72·3 per cent. the whispered voice was heard below the normal standard distance in the worse ear. This disability may be classed as slight 22·9 per cent. ; moderate 16·9 per cent. ; and severe 32·5 per cent.

2. Smaller defects of hearing which were present are indicated by the pure tone audiometer where the percentage was raised to 92·8 per cent. However, a fairly close correlation is noted between the whisper and audiometer tests for the grosser defects of hearing as the relative percentages were slight (Standard I) 38·6 per cent. ; moderate (Standard II) 42·1 per cent. ; severe (Standard III) 30·1 per cent.

3. The impairment of military efficiency is best indicated by the hearing for the whispered voice in the better hearing ear. In 65·1 per cent. the hearing for the good ear was normal or over ten feet and it can be considered that the soldier's military efficiency had been unaffected or only slightly impaired. In 15·7 per cent. however, there was considerable impairment (below ten feet) and in 19·3 per cent. the impairment was severe (below five feet) i.e. moderate or severe impairment of military efficiency in 35 per cent. of the patients.

4. In 61·4 per cent. the deafness was of an inner-ear type, whilst in 28·9 per cent. it was mixed.

Aural Trauma Caused by Gunfire

TABLE I
SUMMARY OF AUDITORY FUNCTION
(Expressed in percentages)

Branch of Service	No of Pat ients	Audiometer Test (Worse ear only)				Whispered Voice Test (Worse ear only)				Whispered Voice Test (Better ear only)				Type of Deafness			
		Normal	Standard I	Standard II	Standard III	Normal	10 to 20 feet	23 to 30 feet	34 to 40 feet	Normal (over 20 ft.)	20 ft. 11 ft.	10 ft. 6 ft.	5 ft. or below	Nil	Nerve	Mixed	Conduction
Field Artillery	26	3.9% (1)	27% (7)	27% (7)	42.3% (11)	27% (7)	15.4% (4)	23.1% (6)	34.6% (9)	30.8% (8)	7.7% (2)	38.4% (10)	23.2% (6)	3.9% (1)	76.9% (20)	11.5% (3)	7.7% (2)
A A Artillery	22	4.5% (1)	50% (11)	27.3% (6)	18.2% (4)	31.8% (7)	27.3% (6)	18.2% (4)	22.7% (5)	45.5% (10)	31.8% (7)	9.1% (2)	13.6% (3)	4.5% (1)	50% (11)	45.5% (10)	—
Coast Defence	15	—	33.3% (5)	26.7% (4)	40% (6)	6.7% (1)	26.7% (4)	6.7% (1)	60% (9)	26.7% (4)	40% (6)	—	33.3% (5)	—	53.3% (8)	46.7% (7)	—
Infantry	20	20% (4)	45% (9)	15% (3)	20% (4)	40% (8)	25% (5)	15% (3)	20% (4)	70% (14)	15% (3)	5% (1)	10% (2)	20% (4)	60% (12)	20% (4)	—
Total	83	7.2%	38.6%	24.1%	30.1%	27.7%	22.9%	16.9%	32.5%	43.4%	21.7%	15.7%	19.3%	7.2%	61.4%	28.9%	2.4%

TABLE II
RELATION OF MEDICAL HISTORY TO HEARING STANDARDS

Standard of Hearing	No of Patients	Age Group		Over 40 years	Civilian Occupation			Previous aural history	Family history	Naso-pharyngeal history	Previous severe illnesses	Army Grade			Psychological disturbance
		20-30 years	30-40 years		Normal	Noisy	Very Noisy					A	B	C	
Normal	6	4 (66.7%)	2 (16.7%)	1	6	—	—	1	—	5	1	5	1	—	2
Standard I	32	12 (36.9%)	19 (59.4%)	1	21	10	1	3	4	15	8	24	6	2	8
Standard II	20	10 (50%)	9 (45%)	1	12	8	—	6	3	10	1	15	5	—	6
Standard III	25	13 (52%)	10 (40%)	2	17	8	—	5	5	13	3	15	9	1	14
Total (expressed in percentages)	83	47.0%	47.0%	6.0%	67.5%	32.3%	1.2%	28.1%	15.7%	51.8%	15.7%	71.1%	35.3%	3.7%	36.2%

5. The frequency with which a severe degree of acoustic trauma (Standard III) was sustained is approximately twice as great among the Field Artillery and Coast Defence as among the Anti-Aircraft and Infantry personnel. It should, however, be noted that mixed type of deafness was more frequent among the Coast Defence and Anti-Aircraft personnel, who were probably of a lower aural standard on enlistment.

The Relationship of Extraneous factors to the incidence of Deafness

Circumstances indicative of extraneous factors which may affect the auditory function of the soldier are of two varieties :—

- (a) Attendant medical circumstances, which give an indication of the man's health before subjection to aural trauma, and, in addition, take into account any psychological disturbance which may have resulted from his experience of gun-fire.
- (b) Attendant military circumstances, which indicate the military conditions when his aural trauma was sustained.

(a) MEDICAL

1. Age

The patients were equally distributed over the decades 20-30 years and 30-40 years. There was no evidence to support the view that age influenced the degree of aural trauma produced.

2. Civilian Occupation

In almost one-third of the patients, the former civilian occupation of the patients could be classed as noisy or very noisy. This may have affected their auditory acuity prior to enlistment.

3. Previous Aural History

18·1 per cent. of the patients gave a history of previous aural trouble. Very few of these acknowledged that their hearing was poor on enlistment. But this is not significant since in civilian life the reluctance of a deaf person to admit any disability is well known. Further, unless the examination is made by an otologist, minor degrees of disability may pass unrecorded because of the great reserve of hearing possessed by a normal individual.

About one-third of the patients brought Medical History Sheets with them, but, for the most part, these proved of little value owing to the poor aural records made. Only, when a previous specialist's report was available, were they of any real interest.

4. Family History

15·7 per cent. of the patients gave details of a family history which might have some bearing on their aural trauma. Often, this was of rather an indefinite character and considered as a whole, the opinion is expressed that heredity plays a negligible part.

Aural Trauma Caused by Gunfire

5 *Nasopharyngeal History*

Over 50 per cent gave a history of previous sore throats, or some degree of nasal obstruction. On examination, however, in only five patients was it considered that any nasopharyngeal disease was sufficiently gross to influence the degree of deafness of the patient to any material extent.

6 *Previous Severe Illnesses*

Only 15.6 per cent of the patients had experienced any previous severe illnesses at any period of their life. In most cases, the relation of these previous diseases to any deafness present was extremely problematical. Special enquiry was made with regard to the administration of quinine for malaria, but few of the patients had been abroad. It is considered that, in the present series, any previous diseases which the patients may have experienced were of negligible significance in the production of the patients' deafness.

7 *Army Grade*

Regarded as a whole, these patients must be considered as a class of fit men from the military standpoint on enlistment. At present, over 70 per cent are in Category A. Of those in Category B and C, the vast majority had been so placed on account of their deafness. It was considered that a further 12 per cent in Category A should be regraded because of their deafness.

8 *Psychological Disturbance*

Before each group of patients was examined, the purpose of the investigation was clearly explained and the men were assured that the examination would have no influence on their military career. Care was taken to impress on them the importance of accuracy in their statements, if any benefit was to result from the investigation.

It was considered that in 36.2 per cent of the patients, there was probably some psychological disturbance. This does *not* indicate the absence of a pathological basis for the patient's deafness, but merely that his attitude to gunfire and sometimes to life in general had become so altered that there was a tendency to exaggerate his deafness. In at least three patients (Case Nos. 43, 58, 78) it was considered that the deafness present was largely of a "hysterical" nature. The examiner makes no claim to be a trained psychiatrist and it is possible that some psychological disturbance might be present in a greater proportion of patients.

(b) MILITARY HISTORY

Table IIIa shows the relationship between the Standards of Hearing and the military history as it may be influenced by different weapons.

Table IIIb is really a consolidation of Table IIIa and shows a similar relationship over the whole range of weapons used.

E. G. Collins

Explanatory Notes

1. Experience of Gunfire

Many patients had had experience of different types of guns, but the number of rounds fired on all types have been added together, where possible, and the following broad classification has been adopted :—

- (a) Light = under 100 rounds.
- (b) Moderate = 100-500 rounds.
- (c) Heavy = 500-1,000 + rounds.

Much of the information was only approximate, but sufficient data was available to form a very fair estimate.

2. Position in Gun Team

To understand these positions fully, a chart showing the position occupied by each member of the gun crew with the various types of weapons must be studied. The following will give a general idea of the position the patient occupied, though considerable variations occur with the different types of guns :

- (a) No. 1 is in command of the gun, occupying a position within a radius of ten feet of the trail.
- (b) No. 2 is to the right of the gun and is responsible for the opening and closing of the breech and the firing of the gun.
- (c) No. 3 is to the left of the gun and is responsible for laying the gun.
- (d) No. 4 is to the left of the gun just to the rear of the breech and is responsible for loading the gun.

Other numbers are concerned with the ammunition and are stationed behind and to the side of Nos. 2, 3 or 4. Where a patient has been employed on some special duty such as sequence recorder, this is recorded in the special column, which also includes numbers which do not easily fit into this general plan.

But the position of the patient in relation to the gun-muzzle was determined by a study of the charts showing the relative positions of the gun crew with the various types of guns.

normal in the following circumstances

About the circumstances which the patient considers had an influence on them, but, in the case of his injury. In nearly all cases, the statements were based on aural records

available, were of the ammunition. Under this is included supercharges, special types of ammunition, "short bursts" and "old"

15.7 per cent. This indicates the reflection of blast from rather an indefinite blast walls, special gun sites, additional blast shields expressed that her head shields) and concrete ammunition emplacements.

Aural Trauma Caused by Gunfire

Type of Gun	No of Patients	Exposure of Gunfire			Duration of Injury				Position in Gun Team				Special Duty Number	Ear Plugs	Cotton Wool	Other forms	Ammunition	Blast Reflection	'Unprotected' blast	Unusual position	Unexpected gunfire	Normal	Standard I	Standard II	Standard III		
		Light	Moderate	Heavy	1 6 months	6 12 months	1 2 years	Over 2 years	No 1	No 2	No 3	No 4														Ammunition Number	
25 pdr	6	3	2	1	4	2	-	-	-	2	1	3	-	6	-	-	1	-	-	-	1	1	2	2			
18 25 pdr	6	-	-	6	1	1	2	2	2	1	1	1	-	1	5	-	2	1	1	-	-	-	1	2			
2 pdr	3	2	1	-	-	1	2	-	-	1	-	1	-	1	3	-	-	1	2	-	1	-	4	2	2		
6 pdr	8	1	1	6	1	4	3	-	2	4	-	1	-	1	5	1	2	1	-	-	-	1	-	1	1		
6 in How	2	-	2	-	1	1	-	-	-	-	2	-	-	2	-	-	-	1	-	-	-	-	-	-	1		
17 pdr	1	-	-	1	-	-	1	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	1		
40 mm	5	-	2	3	1	3	1	-	1	1	-	1	-	2	5	-	-	2	1	1	-	1	1	3	-		
3 7 in	13	2	4	7	5	6	1	1	3	2	3	-	5	-	8	5	3	1	4	2	-	-	8	2	3		
4 5 in	3	-	2	1	1	1	1	-	-	-	-	2	1	-	3	-	2	-	-	-	-	1	1	1	-		
3 in	1	-	-	1	-	-	1	-	-	-	-	-	-	1	1	-	-	1	1	-	-	-	1	1	1		
4 7 in	3	1	2	-	-	3	-	-	1	1	-	-	-	1	-	1	2	-	2	1	-	-	2	1	2		
12 pdr	5	1	3	1	1	3	-	1	3	-	1	-	1	3	-	2	-	1	1	1	-	-	1	-	-		
6 pdr	1	-	1	-	-	1	-	-	-	2	-	-	-	-	1	-	-	1	2	1	2	-	1	3	1		
6 in	5	2	2	1	-	-	3	2	-	1	2	-	-	2	5	-	-	1	2	1	-	-	-	-	1		
9 2 in	1	1	-	-	1	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	1	-	1		
Machine gun	2	1	1	-	-	1	1	-	-	2	-	-	-	-	2	-	-	-	-	-	-	1	-	-	-		
Tommy Gun	3	-	3	-	-	2	-	1	3	-	-	-	-	-	3	-	-	-	-	-	-	1	2	-	-		
Lewis Gun	1	-	-	-	1	1	-	-	-	1	-	-	-	-	1	-	-	1	1	1	-	-	1	2	1		
Bren	4	1	2	1	1	2	1	-	3	-	-	-	-	1	4	-	-	2	2	2	-	-	1	3	-		
Rifle	4	2	1	1	-	-	2	2	3	-	-	-	-	1	4	-	-	1	1	-	-	-	-	-	2		
Anti tank rifle	2	2	-	-	-	-	2	-	1	-	-	-	-	-	1	1	-	1	1	-	-	-	-	-	-		
Mortar	4	1	2	1	1	-	3	-	1	3	-	-	-	-	4	-	-	1	1	1	1	-	1	2	1		
Total	83	20	31	32	18	32	24	9	23*	22	10	10	6†	12	67	3	11	2	8	11	21	10	4	6	3	20	25

Field Artillery

Coast Defence

Infantry

A 2

+ All in A = 27.3 per cent of A +

* All in A = 27 3 per cent of A A

* Eleven of these were Infantry firing small arms

TABLE IIIb.
RELATION OF STANDARDS OF HEARING TO MILITARY HISTORY

Standard of Hearing.	No. of Pat- ients.	Experience of Gun-fire.			Duration of Injury.				Position in Gun-Team.				Relation of worse ear to muzzle.	Protection used by Patient.					Miscellaneous Circumstances.					
		Light.	Moderate.	Heavy.	1-6 months.	6-12 months.	1-2 years.	Over 2 years.	No. 1.	No. 2.	No. 3.	No. 4.		Ammunition Number.	Special Duty Number.		Ear plugs.	Cotton Wool.	Other forms.	Ammunition.	Blast Reflection.	"Unprotected" blast.	Unusual position.	Unexpected Gun-Fire.
Normal	6	1 16.6%	3 50%	2 33.3%	2	3	1	1	1	2	1	1	1	2	±5	6	1	1	1	1	2	1	1	
Standard I	32	4 12.5%	12 31.3%	16 50%	8	12	8	4	14	6	2	4	3	3	±10 +15 -7	26	1	5	2	2	9	5		
Standard II	20	4 20%	9 45%	7 35%	4	9	6	1	2	5	4	2	2	5	±11 +6 -3	15		3	2	3	8	3	2	
Standard III	25	11 44%	7 28%	7 28%	4	8	9	4	6	9	4	3	1	2	±10 +11 -4	20		2	3	4	2	1	2	
Total	83	20	31	32	18	32	24	9	23*	22	10	10	6†	12	±36 +33 -11	67	3	11	2	8	11	21	10	4
						78.3%				26.5%						80.7%				25.3%				

* Eleven of these were Infantry firing small arms.

† All in A.A.—27.3 per cent. of A.A.

± indicates that both ears were equally affected.
+ indicates ear nearest muzzle.
- indicates ear further from muzzle.

Aural Trauma Caused by Gunfire

- (c) "*Unprotected*" Blast This is where the patient considered there was no protective shield between him and the source of blast This may be due to the position of the patient or the position of another gun firing in relation to his gun
- (d) *Unusual position* The patient was occupying an irregular position or one directed by special circumstances
- (e) *Unexpected gunfire* The patient has experienced gunfire when he was not prepared for it, owing to the accidental firing of the gun or a misunderstanding with regard to orders

One or more of these circumstances may be operative in the same patient

Conclusions

1 *Experience of Gunfire*

The degree of aural trauma sustained was *not* related to the patient's experience of gunfire in the present series (cf percentages Standard I and Standard III)

2 *Duration of Injury*

In 78 3 per cent the deafness had been present for over six months and in nearly 40 per cent for over one year In these patients, experience suggests that the expectation of any improvement in hearing is small

3 *Position in Gun Team*

If the patients who have been firing small arms and who have been classed as No 1 are excluded, it is considered that No 2 in the gun team is most likely to sustain aural trauma from gunfire

An important exception to this general statement is in the A A, where the ammunition numbers are unusually exposed to blast owing to the high elevation and wide range of traverse Reliable warrant officers have confirmed this statement from practical experience and, in the present series, 27 3 per cent of A A personnel affected were ammunition numbers

4 *Relation of Worse Ear to the Muzzle*

In about 40 per cent the ear affected was nearer the muzzle of the weapon In 43 per cent, both ears were affected approximately to an equal extent and in 17 per cent the ear further from the muzzle sustained the greater damage

5 *Protection*

80 per cent of the patients used no local protection to their ears It was not possible to demonstrate less acoustic trauma among those patients who did use protection but it is considered the numbers are too small to draw any justifiable conclusion A number of patients admitted that the protection was inadequately applied Three patients stated the cotton

wool had been sucked out by blast and another patient admitted the cotton wool he applied was much too small as he had given some of it to the other members of the gun crew.

6. *Miscellaneous Circumstances*

It would appear that these played a considerable part in the production of aural trauma in the present series of patients. Especially was this the case with regard to "unprotected" blast (25 per cent.). 12 per cent. of the patients occupied unusual positions and in about 10 per cent. of the patients affected, the ammunition or charge was blamed.

7. *Individual Weapons*

The figures for the majority of the weapons are too small to draw any real conclusions.

It is, however, suggested that the greatest degree of aural trauma is caused by the 25 pdr., and 18-25 pdr., the 12 pdr. and the anti-tank rifle. The 3·7 in. A.A. gun was the main offender among Anti-Aircraft weapons, but the degree of deafness it caused was not so severe as those mentioned above.

Relation of Symptoms to the Standards of Hearing and Branches of the Service

In the table which follows, four subdivisions of symptoms are made :—

- (a) *Acute*. This indicates symptoms which occurred at the time or within 38 hours of injury.
- (b) *Gradual*. This indicates the symptoms which were of slow development after the injury and which usually increased in severity.
- (c) *Persistent*. This indicates symptoms which were present at the date of examination.
- (d) *Aggravated*. This indicates symptoms which were aggravated by gunfire or loud noise to a greater extent than was present before the injury.

At the bottom of the table an estimate has been made of the number of patients who sustained rupture of the tympanic membrane. The estimate is based on a careful study of the history of discharge or bleeding from the ear and by information furnished from Medical Officers and Specialists' reports as well as from the result of examination. In all cases where bleeding from the ear was noticed by the patient, it has been considered that a rupture of the tympanic membrane was present. The proportion of patients who actually suffered from this injury is probably much greater than indicated as care was exercised in excluding a large number of cases of chronic suppurative otitis media from this investigation and also there may be no symptom or sign which will lead to a diagnosis unless the ear is examined at the time of the injury.

Aural Trauma Caused by Gunfire

TABLE IV.
RELATIONS OF SYMPTOMS AND SIGNS TO HEARING STANDARDS

Symptoms	No of Patients	Character				Standard of Hearing				Branch of Service			
		Acute	Gradual	Persistent	Aggravated	Normal	Standard I	Standard II	Standard III	Field Artillery	A. A. Artillery	Coast Defence	Infantry
Deafness	81 (98%)	78	3	54	28	6	31	19	25	25	22	14	20
Tinnitus	73 (88%)	69	6	39	20	4	32	19	20	19	20	14	20
Pain	31 (37%)	31	—	—	8	1	10	7	13	12	9	8	2
Bleeding	24 (29%)	23	1	—	1	—	9	5	10	13	6	2	2
Discharge	13 (16%)	5	8	—	—	1	5	2	5	—	6	5	2
Rupture of T.M.	41	Healed 40		Open 1		2	13	1*	14	13	14	9	5

Conclusions

In nearly every case, the patient was able to give a definite date and relate some definite incident when he considered he received his aural trauma

1 Deafness

Deafness at the time of injury was a symptom in practically all the patients and in only three patients was either the onset delayed or else the deafness had occurred over a gradual period of time. Two thirds of the patients complained of deafness still being present at the date of examination. Rather more than one-third of the patients considered that deafness was now aggravated by gunfire to a greater extent than had been present before their injury.

2 Tinnitus

In 88 per cent of the patients, this symptom was present. Usually the onset was acute and occurred at the time of injury. In 47 per cent of the patients, the tinnitus had persisted and was present at the date of the examination and in 24 per cent the patients considered that the tinnitus was aggravated by gunfire.

3 Pain

In approximately 37 per cent of the patients, pain was experienced at the time of the injury, but in rather less than 10 per cent was it a symptom which tended to recur on aggravation by gunfire.

4 Bleeding

Bleeding from one or both ears was present in 29 per cent of the patients and was considered to be one indication of a rupture of the tympanic membrane. It was usually of short duration.

5. Discharge

Discharge from one or both ears had been present in 15 per cent. of the patients. In 6 per cent. the discharge occurred within the first 48 hours and in 9 per cent. it was gradual in onset. Any patients in whom the discharge persisted have been transferred to the miscellaneous group and will be considered separately.

The symptoms were present in fairly equal proportions in the various branches of the service examined, with the exception of bleeding and pain, which were more common among the Field Artillery personnel and which were infrequent among the Infantry patients.

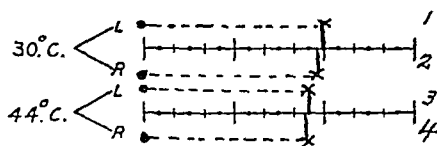
Ruptured Tympanic Membranes

It was estimated that about 50 per cent. of the patients had sustained rupture of one or both tympanic membranes. The majority of the ruptures had healed well and on examination there was little evidence of any perforation, even with the magnified view of the electric otoscope. The statement that "Patients who sustain rupture of the tympanic membrane are left with little residual deafness" would appear to be quite erroneous. 32.5 per cent. of this group of patients had a hearing loss of Standard III, which is if anything rather greater than in the remainder, who may be regarded as cases of pure concussion deafness without rupture. The patients with rupture of the tympanic membranes were fairly equally distributed over the Field Artillery, Anti-Aircraft Artillery and Coast Defence, but the Infantry personnel suffered much less from this injury, only 20 per cent. being affected.

II. Labyrinthine Function

Labyrinthine function was tested by means of the caloric test only, using the procedure laid down by Cawthorne, Fitzgerald and Hallpike (1942). The technique proceeds on the following lines:—

Each ear is irrigated in turn for 40 seconds with cold (30°C.) and hot (44°C.) tap water. The nystagmic duration is measured by means of a stop-watch starting at the application of the stimulus. The results are recorded graphically on a chart as shown below:—



NORMAL

FIG. 1.

Each straight line represents a three minute period divided into ten second intervals. For reference the reactions are numbered 1-4 from

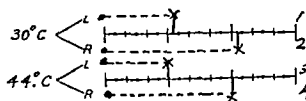
Aural Trauma Caused by Gunfire

above downwards The termination of the nystagmic responses are marked on the chart by crosses The Fig 1 represents an average normal result with the duration of the cold responses close together at about two minutes, and the hot responses slightly less

Two distinct types of abnormality are described (1) Canal Paresis, (2) Directional Preponderance

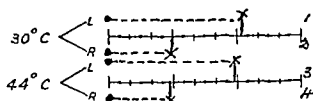
(1) Canal Paresis

This is thought to denote a diminished sensitivity of the external semicircular canal equally for hot and cold stimuli, without any disturbance of the opposite canal Figs 2 and 3 are characteristic respectively of left and right canal paresis



LEFT CANAL PARESIS

FIG 2

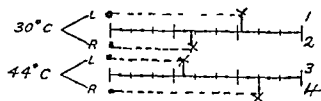


RIGHT CANAL PARESIS

FIG 3

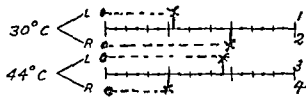
(2) Directional Preponderance

This is thought to denote a control facilitation of peripheral stimuli, including caloric stimuli which usually causes nystagmus in a particular direction Thus in Directional Preponderance to the right, responses 1 and 4 (which normally cause nystagmus to the right) are prolonged with respect to responses 2 and 3 (which normally cause nystagmus to the left) Figs 4 and 5 are characteristic of this reaction



DIRECTIONAL PREPONDERANCE
TO RIGHT

FIG 4



DIRECTIONAL PREPONDERANCE
TO LEFT

FIG 5

Often only one type of abnormality is present but both may occur in combination with appropriate alterations in the pattern of the responses It will be observed that this procedure gives a quantitative and qualitative interpretation to the caloric test not available previously In this investigation I found that the interpretation of the test required considerable experience and constant practise, and even then it was not always possible to be dogmatic about the results

The main difficulty is in determining the end-points of the induced nystagmus. Unfortunately, this difficulty arises more frequently among those patients in whom one is virtually certain there is a labyrinthine lesion than in the patients with normal reactions. It is almost analogous to knowing that a patient has an acute abdomen, and yet being unable to determine the exact diagnosis. The character and amplitude of the nystagmus will sometimes provide an additional aid. When all due allowance is made for these difficulties, the opinion is held that the observational error does not exceed ten seconds, but in order that the results recorded in this analysis may present a fair and unbiased expression of opinion, it is proposed to divide the abnormal reactions into the two categories of definite and doubtful. It would be erroneous to ignore the doubtful results completely but, at the same time, they do not carry as much weight as the definite results and should be regarded more as an indication of labyrinth dysfunction rather than as a definite diagnosis of a labyrinthine lesion. Besides the abnormal reactions already mentioned reference will be made to:—

- (1) *Mixed Reaction, Unilateral.* A canal paresis present in one ear with a directional preponderance present to the same side.
- (2) *Mixed Reaction, Bilateral.* A canal paresis present in one ear with a directional preponderance to the opposite side.

Where a complete canal paresis was indicated when using water at the standard temperatures (30°C. and 44°C.), an attempt was made to see if any residual function remained by decreasing the temperature of the water to about 20°C. and repeating the test, thus providing a greater stimulus. The tests were not performed on discharging ears or on patients who showed a bad ocular nystagmus as the results would be of little comparative value. Discussion on the interpretation of the results will be made later in this report. In the summary which follows, various explanatory notes are necessary:

- (1) Vertigo has been divided into four categories: immediate, gradual, definite and doubtful. The first two categories refer to the mode of onset, whilst the latter two are concerned with the character of the vertigo. In many cases, the history is not suggestive of a labyrinthine type of vertigo or the vertigo may have been present before the injury. In such cases the patient's vertigo has been classed as doubtful.
- (2) By further analysis of the relationship of the labyrinthine lesion to the worse hearing ear and comparing it with the standards of hearing in both ears, it has been possible to summarise in Table V the association between labyrinthine disorder and the disturbance of cochlear function.

Aural Trauma Caused by Gunfire

TABLE V
SUMMARY OF LABYRINTHINE FUNCTION (CALORIC REACTIONS)

Type of Reaction	No of Patients (Total = 60)	Character of Reactions		Units				Symptoms						Signs		Associated with cochlear trauma	Not associated with cochlear trauma	Hearing Standard					
		Definite	Difficult	Field Artillery	A A Artillery	Coast Defence	Infantry	Vertigo (Immediate)	Vertigo (Gradual)	Vertigo (Definite)	Vertigo (Doubtful)	Nausea	Vomiting	Headache	Rombergism			Spontaneous Nystagmus	Normal	Standard I	Standard II	Standard III.	
Normal	37	37	-	12	9	5	11	4	13	4	13	3	2	14	9	6			4	14	9	10	
Unilateral Canal Paresis	9	7	2	6	2	-	1	2	4	5	1	3	1	2	3	1	4	2	-	2	1	6	
Bilateral Canal Paresis	3	3		1	1	1	-	-	-	-	-	-	-	-	-	-	1	-	1	1	1		
Directional preponderance	24	19	5	6	6	6	5	7	6	9	4	2	1	4	1	2	6	8	10	2	13	4	5
Unilateral Mixed Reaction	4	3	1		1	2	1	-	-		-	-	-	-	1	-	9	9	-	1	2	1	
Bilateral Mixed Reaction	3	1	2	1	-	1	1	1	2	2	1	2	1	1	1	1	9	9	-	2	1	1	
Total (exclusive of normal)	43	31	10	14	10	10	8	10	12	16	6	7	3	7	6	5	12	12	19	2	18	9	14
	53 75%	41 5%	12 5%						22														

* Indicates relation of cochlear function to canal paresis only

Conclusions

1. *Frequency*

53·75 per cent. of the 80 patients tested showed evidence of disturbance of labyrinthine function. In 41·2 per cent. of patients it was considered that an exact diagnosis of the lesion could be made, whilst in 12·5 per cent. the reactions were difficult and the diagnosis more uncertain.

2. *Distribution*

The distribution in relation to the totals of the various branches of the service examined was :—

Coast Defence, 66·6 per cent.

Field Artillery, 56 per cent.

Anti-Aircraft, 44·6 per cent.

Infantry, 40 per cent.

The Coast Defence personnel and the A.A. showed the greatest evidence of quiescent chronic otitis media on examination (cf. Table I, "Cases of Mixed Deafness"). This may have influenced the results of the caloric tests in these branches of the Service.

3. *The Reactions*

(a) *Normal*. Whilst 46 per cent. of the reactions were normal, there were some patients (notably Case Nos. 36, 38, 43, 47, 58, 72, 78) where the result came as a surprise in view of the symptoms and signs of rombergism or spontaneous nystagmus, which were present. Cawthorne, Fitzgerald and Hallpike consider that the caloric reaction tests, the horizontal semi-circular canal only, and it is possible that in these patients a lesion of the vertical semi-circular canals was present, but was not demonstrated. The normal reactions bore no relation to the degree of hearing loss.

(b) *Unilateral Canal Paresis*. This constituted 21 per cent. of the abnormal reactions. It was most common amongst the Field Artillery personnel and was more frequently correlated with a severe degree of acoustic trauma (Standard III).

(c) *Bilateral Canal Paresis*. This formed only 7 per cent. of the abnormal reactions and the figures are too small to warrant any deductions being made.

(d) *Directional Preponderance*. About 56 per cent. of the abnormal reactions showed directional preponderance. The affected patients were distributed fairly equally over the various branches of the Service. The reaction occurred most frequently (63 per cent.) among those patients with only a slight degree of aural trauma or with normal hearing (Standard I or Normal).

(e) *Mixed Reactions*. The figures for the mixed reactions are again very small and do not warrant any deductions.

Aural Trauma Caused by Gunfire

4 *Symptoms and Signs*

Vertigo was a symptom in nearly 50 per cent of the patients with normal reactions and was present in about the same proportion in those with abnormal reactions. It is difficult to decide if vertigo is really of a labyrinthine character or not but as far as could be estimated a true labyrinthine type of vertigo was present in about 11 per cent of the patients with normal reactions and in about 37 per cent of those with abnormal reactions. In this latter group, half of the patients gave a history of delayed onset. Unconsciousness, usually of short duration, was more frequently encountered among these traumatic lesions than is the case of a labyrinthine disease, such as Meniere's disease.

Nausea and vomiting were not frequent symptoms, the former being present in only 15 per cent of the patients with abnormal reactions and the latter in only 7 per cent.

Headache This symptom was present in just over 25 per cent of the patients, but of these the vast majority had normal caloric reactions and in only seven patients (8 per cent) was it connected with abnormal reactions. Where these were present, the tendency was for the abnormal reaction to show a directional preponderance rather than a canal paresis. Usually the headache was of gradual onset and frequently occurred some months after the original injury. The opinion is expressed that in the majority of patients it is of psychogenic origin but that where it is possible that it is associated with a labyrinthine lesion, that lesion is more likely to be indicated by a directional preponderance than a canal paresis.

Rombergism and spontaneous nystagmus were again infrequent and were in fact rather more common among patients with normal reactions than those with abnormal reactions. Often they were of rather an indefinite character.

The conclusion drawn from this analysis is that there is no close correlation between symptoms and signs suggesting labyrinthine disease and the actual results of clinical examination by the caloric test. Directional preponderance is more often associated with a slight degree of hearing loss (Standard I), whilst if a canal paresis is present the hearing loss is liable to be severe (Standard III).

Miscellaneous Group

Though these patients have been placed in a separate group, they present several points of interest.

1 *Patients with no evidence of Aural Trauma* (Case Nos 84, 85)

In these two patients, it is considered there is no real evidence that they sustained any aural trauma.

2 *Patients with Chronic Suppurative Otitis Media* (Case Nos 86-93 inclusive)

These eight patients all had active suppurative otitis media in one or both ears on examination. Four of the patients gave a history of

previous aural discharge in civilian life, but only two admitted that the ears were discharging on enlistment. These latter had a hearing loss of Standard I and Standard III whilst the general distribution was Standard I (two), Standard II (three) and Standard III (three). Five of the patients stated that the symptoms of deafness, tinnitus and discharge were aggravated by gunfire whilst one stated the ears bled with gunfire. Four of the patients belonged to the Coast Defence, two to the A.A. and two were in the Field Artillery. Four of the patients heard a whisper even in the better ear at a distance below five feet, whilst in two it was below ten feet. Consequently, taken as a group, the conclusion is that their military efficiency was considerably affected. Two of the patients only were using any form of local protection at the time of the incident when they consider they sustained the greatest damage to their ears. Five of the patients gave some history of vertigo ; in three patients there was rombergism, and in four some spontaneous nystagmus was present. The caloric tests were not done on the ears which were discharging, but of the two patients where the discharge was unilateral, one showed normal reactions in the sound ear and the other showed a canal paresis. The group is too small to draw any definite conclusions about the general effect of gunfire on patients with chronic suppurative otitis media.

3. *Patients affected by Explosive Missiles* (Cases Nos. 94-97 inclusive)

These four patients had received aural trauma from the effect of explosive missiles. Two cases were bomb explosions, one shell and one a mortar bomb. Those patients affected by bombs had hearing Standard I and Standard III, the shell had caused a deafness equal to Standard III (one ear only) and the mortar bomb Standard II. The hearing for the whispered voice was most impaired in the patient where a 1,000 lb. bomb dropped fifty yards away and in this patient a whisper was heard in the better ear at a distance below five feet. Apart from this patient, the military efficiency of the men had not been greatly impaired. None of the patients were wearing any form of local protection to their ears. With regard to the labyrinthine function, only one patient complained of vertigo and had slight rombergism. This had been present before his injury. Examination by the caloric test, however, showed that all four patients had some disturbance of labyrinthine function. In three patients there was a directional preponderance and in one (Standard III hearing) there was a canal paresis, possibly bilateral.

4. *Tank Instructors* (Case Nos. 98-102 inclusive)

These five patients are of interest because of the position they occupy during gunfire. They are either perched on the turret of the tank or else have their head protruding from the turret ; thus their ears are relatively unprotected from the blast of the gun. Three of them were

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exposed to blast from the 2 pdr gun and two from the 6 pdr. With regard to the deafness in these patients, one patient had normal hearing, three had a hearing loss equal to Standard II and one had a hearing loss equal to Standard I. The hearing for the whispered voice and military efficiency had been severely impaired in two (whispered voice in better ear six inches and six feet), moderately impaired in one (whispered voice in better ear nine feet). Two of the men were wearing protection at the time of the incident (1 fibre ear plugs, 1 flannelette ear plugs). With regard to labyrinthine function four patients complained of some vertigo, in one patient rombergism was present and in two there was some spontaneous nystagmus. On examination with the caloric test, two patients showed a mixed reaction of canal paresis in one ear and a directional preponderance, possibly suggestive of an utricular paresis, in the opposite ear. Both had a Standard II hearing loss.

5 *Patients Operating Predictors and Recording (Case Nos 103-108 inclusive)*

Of the six patients in this group, five were women in the A T S attached to A A batteries. The majority of the patients were 10-20 yards away from the guns but were unprotected from blast. Two patients through special circumstances approached much nearer the guns. The hearing standards were Standard I in three patients, Standard II in one and Standard III in one. The patient with a hearing Standard III was 50-75 yards away from the guns, but the guns fired directly over him and he sustained a rupture of his tympanic membrane. It was considered that only in this patient was there any real impairment of military efficiency and even then it was not very severe (whispered voice in better ear at a distance of thirteen feet). None of the patients was wearing any protection. In the majority of patients no form of protection was possible as good hearing on predictor work is essential. (Some members of the predictor crews are, however, partially protected by headphones.) With regard to labyrinthine function four of the patients complained of some vertigo, one had slight rombergism but none had any spontaneous nystagmus. Examination with the caloric test showed a canal paresis in three patients, two of them being women, and a directional preponderance in one woman. The patients with a canal paresis showed a greater degree of deafness than the case with directional preponderance.

Discussion

INTRODUCTION

Whilst many papers have been published on occupational deafness and industrial trauma to the ears, the question of aural trauma caused by gunfire has received scant attention. As the number who actually complain of permanent deafness due to gunfire is relatively small (only 400 patients were included in a special War Office list compiled for this investigation) it may be argued that the subject does not merit more serious

membrane was ruptured. No attempt was made to give a quantitative interpretation to this finding and the frequency with which labyrinthine disturbance may follow aural trauma from gunfire has not previously been ascertained.

With regard to the symptoms, the patients clinically appeared to fall fairly closely into the two groups which have been described by Ramadier and Causse (1938). The first is the central or cerebro-labyrinthine type and the second, the peripheral or true labyrinthine type. If we consider first the central type, Ramadier and Causse describe the following four characteristics as being diagnostic. (1) Atypical vertigo; (2) An excitable labyrinth; (3) absence of any complaint of deafness; (4) headache and psychological disturbance. With regard to hearing, the authors admit that there are often small deficiencies of hearing not noticeable by the patient. In this investigation, the group of patients who showed directional preponderance bears some striking resemblance to this type. The second group is the peripheral or labyrinthine form where the main symptoms are deafness, severe tinnitus and for some weeks vertigo. In these the vestibular labyrinth is hypo-excitable and the group of cases which have been shown to have a canal paresis conform to this description. A fuller summary of the characteristics of the two types can be found in an article by Horgan (1942).

It is interesting to compare the labyrinthine disturbance in this investigation with a group of patients with Ménière's disease, whose labyrinthine function was carefully analysed by Cawthorne, Fitzgerald and Hallpike (1942). In Ménière's disease, nausea and vomiting were much more common. No note was made of unconsciousness in the patients with Ménière's disease, but we know it is very infrequent. In these traumatic cases, a history of unconsciousness was obtained from five patients. The subjective symptoms of deafness and tinnitus occur approximately with the same frequency in the two groups, whilst the numbers of patients with objective deafness also show a close resemblance though the severity of the deafness is greater in Ménière's disease. The main difference between the two groups occurs in the type of labyrinthine disturbance. In Ménière's disease, the proportion of canal paresis to directional preponderance is about 3:1, whereas in the traumatic cases there is a complete reversal and the proportion is 1:2. If we accept the view of Cawthorne, Fitzgerald and Hallpike (1942) that directional preponderance is due to a paresis of the utricle, this would appear to indicate that the utricle is more susceptible to trauma than the semi-circular canals. There are, however, other interpretations available for the occurrence of directional preponderance. The interpretation that the above authors make is a reasoned one, based on the results of animal experiments and deduced by a process of exclusion. But, it is possible that directional preponderance may be due to a *hyper*-sensitivity of the utricle as much as to a *hypo*-sensitivity. This supposition

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It was much more usual for the frequency 8192 to show a progressive elevation of the auditory threshold and often the decibel loss was severe over the speech frequencies immediately preceding 4096. With war injuries to the ear, it is probable that the cochlear suffers concussion to a greater extent than ever occurs in industrial trauma and though recovery takes place to some degree, the permanent damage that remains is liable to be spread over a greater area. Of the present series of patients, the vast majority showed a maximum decibel loss over frequency 8192, which was the highest frequency tested.

Pathology

The exact pathology of the aural lesion produced in man by gunfire trauma is uncertain, though the evidence that pathological changes are produced in the ears of animals subjected to blast is considerable. But conclusions drawn from these experiments must be treated with caution. The work of J. S. Fraser and John Fraser submitted to a meeting of the Royal Society of Medicine in 1917, still provides the most reliable study. Of the six cases in which Fraser made a histological examination of the temporal bones, Case Nos. 3, 4 and 5 appear to provide the best examples of the effect of blast as they had no direct injury to the skull. The tympanic membrane was ruptured in two of the patients (Cases 3 and 4). In Case 5, a plug of wax in the meatus, had possibly given some protection to the middle and inner ear. In this case, beyond some small hæmorrhages into the tympanic cavity, the changes in the middle ear or cochlea were slight, though there was a detachment of the otolith membrane of both the utricle and the cupulae of the lateral and superior canals. Case 3 showed rupture of the tympanic membrane, hæmorrhage into the bony spaces of the middle ear and into the fundus of the internal auditory meatus. The membranous labyrinth was not involved. Case 4, due to a rifle grenade explosion close to the ear, showed the following :—(1) Rupture of the tympanic membrane, (2) hæmorrhages into the tympanic cavity, around the geniculate ganglion and the fossa subarcuata. There was bleeding into the scala tympani in the region of the round window and a hæmorrhage into the fundus of the internal auditory meatus. (3) A "ghost-like" appearance of the organ of Corti with the hair cells and supporting cells indistinguishable. (4) Separation of the otolith membrane of the saccule and of the cupola of the superior canal. Whether similar changes would be found in cases of gunfire deafness is uncertain, but it seems probable that they would be present but not so acute. The difficulties that arise in the interpretation of any pathological changes have been well illustrated in the careful work of Crowe, Guild and Polvogt (1934), on the pathology of nerve deafness and more recently by Wever (1941), in the case of patients exhibiting a "tonal dip". Many patients who showed comparatively gross pathological changes in the cochlea

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on historical examination had almost perfect hearing. Until our knowledge of the physiology of hearing shows further advance, this difficulty in interpretation is liable to remain.

The Causation of Aural Trauma

Though no common predisposing factor was discovered for the causation of the aural trauma, several contributory factors have been mentioned in this report. Two further possibilities which are largely theoretical deserve consideration. The first postulates an individual variation in the sensitivity of the cochlea to blast pressure waves. Payer (1940) and Wilson (1943) have both stressed the individual variations of patients in their sensitivity to auditory fatigue and Wilson has, with some success, attempted to correlate this variation with liability to acoustic trauma. He has suggested that his results provide a possible basis for prophylaxis, as the 'fatigue sensitive' patient could then be guarded from gunfire. Two patients in the present series (Case Nos. 41 and 53) volunteered the statement that they were always sensitive to loud sounds even in civilian life, whilst several others stated that they were more sensitive than their comrades to gunfire or rifle fire, even before their injury had been received. Deafness and tinnitus, in these patients, occurred on only small provocation and took longer to recover than was usual. In twenty-two patients it was the first round of a shoot which caused their aural injury and in fifteen it appeared to be the first time that they had been exposed to fire from the weapon which they considered gave them the injury. The second possibility which has not been fully discussed in the report, is the question of ammunition. Where there are variations in the charge or 'short bursts' the possibility of these being a contributory factor in the causation of aural trauma is obvious. It is not, however, clear why twenty rounds of a standard ammunition may be fired without any effect, and yet the twenty-first round produces an increased blast pressure which is felt by all members of the gun team. It has been suggested by artillery officers with whom the question has been discussed that this difference is due to a variation in the secondary explosions of the gases at the muzzle. This variation, they consider, may take place in spite of the fact that the type and quantity of the charge is essentially similar in each round. A further theory is that there is a poorer fitting of the driving band in some rounds, so that the round is not rammed home so firmly in the breech. This question is obviously one for expert opinion and no doubt has already received attention.

The Effect of Previous Disease and Repetitive Trauma

There is a general view that previous aural disease which is of a middle ear type will lessen the degree of aural trauma but that, if a nerve lesion is already present, the effect of aural trauma will be increased. Owing to the poor aural records which were available, it was not possible

either to deny or to confirm this view and a decision could only be made by subjecting a selected group of patients to a thorough otological examination both before and after several months of gunfire. It is nevertheless suggested that once an aural injury has occurred, it is very unwise, except in unavoidable circumstances, for the patient to continue firing at the guns until opportunity has been given for recovery to take place. This proposal could be implemented only by having the Medical Officer present on the range during firing practice. At many camps, it would appear that this procedure is already adopted but, perhaps, further instruction might be given to medical officers as to the important points in examination, as well as a further emphasis of the necessity for abstention from active interference with the ear. From several patients, the information was still received that drops had been instilled into the ear by the medical officer.

The investigation of Kobrak, Lindsay and Perlman (1941) on auditory fatigue and its relation to frequency and intensity are of some interest in considering the effects of repetitive trauma as a similar parallel might be drawn in the case of aural trauma due to gunfire.

Psychological Deafness

Milligan and Westmacott (1915) and Hurst and Peters (1917) made an investigation of this type of deafness during the last war, but possibly over-emphasized the frequency with which true hysterical deafness occurs. During two years' experience of the treatment of battle casualties from the Western Desert, very few cases of pure hysterical deafness were seen and in the present investigation there are only three patients who possibly fall into this category. Some otologists consider that the majority of concussion deafness is functional in origin, but with this view disagreement is expressed. It is contended that in the vast majority of patients some pathological basis for their deafness can be disclosed if a thorough otological investigation is made, but in a considerable proportion a super-added psychological symptoms with labyrinthine lesions will be discussed later. Further investigation on this subject might prove profitable.

The Duration of Injury and the Prognosis

It has been customary to regard any deafness which exists after six months as permanent, but that this may be inaccurate is suggested by some Scandinavian otologists who found that recovery in the aural trauma produced by rifle fire could take place up to two years after the injury. Whether a similar period for recovery can be expected in trauma from gunfire with the heavier charges employed is undetermined and the solution of this problem is still handicapped by the absence of reliable clinical records. Greifenstein (1940) considers that the earlier the disturbances of equilibrium and tinnitus disappear the better the prognosis. The presence of normal caloric

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reactions has been advanced as an indication of the chance of recovery and some authorities have held that they provide evidence that the deafness is hysterical, but this investigation would not support this view. Abnormal caloric reactions may be present with quite a small hearing loss or at times the hearing may even be normal and *vice versa*, a patient in whom it is considered that there is a severe pathological degree of deafness may have quite normal caloric reactions. Auditory and labyrinthine function, although showing some general correlation, are not necessarily interdependent. A further suggestion has been made by Colledge (1940) that once a concussion deafness is established, there is a progressive deterioration over the whole range of frequencies, so that eventually an early senile deafness is produced. In the present investigation, Case Nos. 12 and 38 seem to confirm this impression but, as the conditions of examination on the two occasions when the patients were tested were not identical, the significance cannot be pressed. If a number of patients from this investigation could be re-examined in five years' time under identical conditions, some useful information would be gained. The importance of securing definite information on this subject is considerable when the time arrives for the allocation of a pension.

The Degree of Disability

There is, at present, no satisfactory method for evaluating the degree of disability that may be caused by a given percentage of hearing loss. A tentative standard of procedure has been evolved by the American Consultants (1942) based on the measurements of hearing loss with a standard audiometer, and a formula has been produced. It lays itself open to some serious objections. Unless the audiometer is correctly calibrated and receives proper attention the results will be unreliable. In addition, like all formulas, it does not take into account the individual with his variation in occupation and the possible adaptation to his handicap through lip reading or a hearing aid.

The standards of hearing which the Army has adopted although they give some idea of military efficiency, are by no means satisfactory and lay themselves open to a variety of interpretations by different observers. It is possible that the mass use of the gramophone audiometer on enlistment in the Army, may provide the best solution, though even with this instrument the results will vary to some extent with the intelligence of the patients.

Labyrinthine Function

Jones-Phillipson (1917) during the last war observed that frequently there was a disturbance of labyrinthine function in "blast" injury to the ears. He made the observation that a greater amount of water was necessary to elicit any reaction of induced nystagmus with the caloric tests and apparently carried out the tests although the tympanic

membrane was ruptured. No attempt was made to give a quantitative interpretation to this finding and the frequency with which labyrinthine disturbance may follow aural trauma from gunfire has not previously been ascertained.

With regard to the symptoms, the patients clinically appeared to fall fairly closely into the two groups which have been described by Ramadier and Causse (1938). The first is the central or cerebro-labyrinthine type and the second, the peripheral or true labyrinthine type. If we consider first the central type, Ramadier and Causse describe the following four characteristics as being diagnostic. (1) Atypical vertigo; (2) An excitable labyrinth; (3) absence of any complaint of deafness; (4) headache and psychological disturbance. With regard to hearing, the authors admit that there are often small deficiencies of hearing not noticeable by the patient. In this investigation, the group of patients who showed directional preponderance bears some striking resemblance to this type. The second group is the peripheral or labyrinthine form where the main symptoms are deafness, severe tinnitus and for some weeks vertigo. In these the vestibular labyrinth is hypo-excitable and the group of cases which have been shown to have a canal paresis conform to this description. A fuller summary of the characteristics of the two types can be found in an article by Horgan (1942).

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would explain the occurrence of a directional preponderance in those patients where the labyrinthine lesion was under Hallpike's interpretation lateralized to the better hearing ear and the diagnosis of utricular irritability in the deaf ear would then be substituted for a utricular paresis in the relatively good ear. At all events, it seems that directional preponderance is an indication of a disturbance of labyrinthine tone. In addition to the utricle, Cawthorne, Fitzgerald and Hallpike have shown that labyrinthine tone may be affected by cortical impulses passing from the temporal lobe to the vestibular nuclei. If "blast" causes petechial hæmorrhages in the temporal lobe (and there is some evidence of this in animal experiments) then a further source of origin for the directional preponderance arises. It has been pointed out by Clarke (1943) that it is also possible for the superior and posterior canals to possess a similar function to the utricle, and this may explain the occurrence of normal reactions in several patients who appeared to have definite vestibular symptoms, as it is probable that the procedure adopted in the caloric test did not give any indication as to the function of these canals.

Further observations on directional preponderance have recently been made by Kobrak (1943). He considers directional preponderance is only one part of a complex reaction which is termed Nystagmus Berereitschaft and he attributes considerable importance to the latency and character of the nystagmus. As yet, our knowledge of labyrinthine function is still in its infancy and most interpretation is, to a large extent, theoretical.

Prophylaxis

The difficulties in providing adequate prophylaxis have already been stressed. It is essential that the soldier retains at least part of his hearing and in some cases it is necessary for the hearing to be really good. Hence, the problem resolves itself into finding a form of local protection which will eliminate blast pressure waves without the elimination to any great degree of sound waves. The Army authorities hold that dry cotton wool properly applied in the external meatus best fulfils these requisites though no claim is made that it affords 100 per cent protection. It is suggested that the correct method of application should form part of the gunner's drill as very frequently the cotton wool which is used is too small or is not packed into the external meatus in a proper manner. The attitude that the application of protection to the ears is to some extent effeminate is still fairly prevalent and requires to be overcome. A further method of local protection which might prove of general benefit is a modification of the steel helmet whereby an extension in the form of a baffle-plate over the ears is added, so that the blast is dispersed. General protection from gunfire blast is more a matter for ordnance experts in the design of suitable shields to the various weapons. If it is necessary for tank instructors to be perched on the outside of a tank, it might be feasible to provide a detachable shield.

Summary

In this clinical investigation of patients who had at some time or other complained of injury to their ears from gunfire, it is considered that :

(1) In 72·3 per cent. the whispered voice was heard below the normal distance in the worse ear. This disability may be classed as slight 22·9 per cent. ; moderate 16·9 per cent. and severe 32·5 per cent.

(2) Smaller defects in hearing were demonstrated by the pure tone audiometer, and with this instrument some degree of deafness was found in 92·8 per cent. The relative percentages for the worse ear were slight (Standard I) 38·6 per cent. ; moderate (Standard II) 24·1 per cent. ; severe (Standard III) 30·1 per cent. The frequency with which a severe degree of acoustic trauma (Standard III) was sustained is approximately twice as great among the Field Artillery and Coast Defence as among the Anti-Aircraft personnel and Infantry. Over the whole range of hearing, the Infantry were least affected.

(3) Frequently both ears were affected. The military efficiency of the soldier as judged by the hearing for the whispered voice in the better ear showed that in 65·1 per cent. the soldier's efficiency had been unimpaired or only slightly impaired. There was, however, moderate impairment in 15·7 per cent. and severe impairment in 19·3 per cent. (a total of 35 per cent. for these two categories).

(4) In 61·4 per cent. of the patients the deafness was of an inner-ear type whilst in 28·9 per cent. it was mixed.

(5) No common predisposing factor in the causation of this deafness was discovered.

(6) Contributory factors were considered to be :

- | | | |
|----------|---|---|
| Medical | { | (a) Civilian occupation (in approximately one-third of the patients the civilian occupation was noisy or very noisy). |
| | | (b) Previous Aural disease (18·1 per cent. of the patients). |
| | | (c) Psychological disturbance (36·2 per cent. of the patients). |
| Military | { | (a) Position of the patient on the gun team (No. 2 in the gun team was most affected). |
| | | (b) Miscellaneous circumstances such as lack of shield protection from blast, reflected blast and ammunition or charge. |
| | | (c) Absence of any local protection to the ears (80 per cent. of the patients). |
| | | (d) Type of weapon (25 pdr., 12 pdr. and anti-tank rifle probably cause most acoustic trauma in the various branches of the Service). |

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It should be noted that in the present series of cases, neither age, heredity, nasopharyngeal disease nor experience of gunfire are considered to have played any important part in the degree of acoustic trauma the patient experienced

(7) Whilst the subjective acoustic symptoms usually indicate some degree of objective deafness, they are not closely correlated with the severity of the objective deafness. Ruptures of the tympanic membrane heal well but it is erroneous to state that a patient who sustains a rupture of the tympanic membrane gets little residual deafness. In 32.5 per cent of patients with ruptured tympanic membranes the residual deafness was severe and in 30 per cent moderate, figures which are comparable with cases of pure concussion deafness without rupture

(8) It was impossible to estimate the prophylactic effect of local protection to the ears as the figures were too small to draw any conclusions. Close questioning of the patient did elicit the fact that, when protection was applied, it was frequently applied inefficiently

(9) Nearly 54 per cent of the patients showed some probable disturbance of labyrinthine function and in 41 per cent, it was felt that a labyrinthine lesion was certainly present. The labyrinthine lesions were divided as follows —

- (a) Unilateral canal paresis (21 per cent of the abnormal reactions)
- (b) Bilateral canal paresis (7 per cent)
- (c) Directional preponderance, indicating a possible utricular paresis (63 per cent)
- (d) Combined reaction of directional preponderance and canal paresis (9 per cent)

The patients with canal paresis were more common among personnel of the Field Artillery, whilst the patients showing directional preponderance were distributed fairly equally. A canal paresis was more frequently associated with a severe degree of deafness, whilst in the patients with directional preponderance, the deafness was more frequently slight.

Regarded as a whole, the labyrinthine symptom gave little true indication of the existence of a labyrinthine lesion. This may be due to the fact that the tests used at present are not capable of recording the function of every part of the vestibular labyrinth.

It is felt that this high proportion of labyrinthine lesions among the patients examined is far greater than would be encountered among an equally fit body of patients in civil life and the conclusion is drawn that gunfire alone can cause a labyrinthine lesion.

(10) A group of miscellaneous cases which are of some interest have been examined but the figures are too small to draw any definite conclusions from the results of clinical examination.

E. G. Collins

In making this investigation my thanks are due to Dr. C. S. Hallpike for much friendly advice and criticism and to the Medical Research Council for the excellent facilities which have been granted.

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CLINICAL RECORD

A CASE OF OTITIC HYDROCEPHALUS

By WILLIAM McKENZIE (London)

SHEILA F, aged 12, admitted to Kingston County Hospital on *June 13th* with acute left otitis media for eight days

Past History

Occasional left earache Eight months before, discharge from the left ear for fourteen days

On Admission

The child was fairly well and had no symptoms except earache The left ear showed a pulsating discharge with an oedematous drum There was nystagmus to the left, and the temperature was 99°F

Penicillin 60,000 units was given three hourly, and she improved, the otorrhoea continued, and the temperature rose occasionally to 99°

June 23rd

Ten days after admission she complained of severe headache and diplopia. The temperature rose to 100 4°F

June 25th

Lumbar puncture Cerebrospinal fluid normal, pressure 80 mm

June 28th

Headache had improved slightly

The margins of the optic discs were blurred, and there was a left external rectus palsy

July 3rd

Headache was slight

Bilateral papilloedema was seen for the first time

July 5th

Lumbar puncture Cerebrospinal fluid normal, pressure 350 mm

At this stage it was decided to explore the mastoid No infection was found, and the wound healed quickly

Lumbar puncture on *July 5th* showed a clear fluid with pressure of 300 mm

The neurologist, Dr F M R Walshe, who saw her on *July 26th* said he had never been really convinced of the existence of "otitic hydrocephalus" as a clinical entity, and that he was afraid some other cause for the raised intracranial pressure would be found, for example medulloblastoma

He advised ventriculography, and at this stage she was transferred to the Atkinson Morley Hospital under the care of Mr Wylie McKissock

Mr McKissock found a right external rectus weakness with a marked bilateral papilloedema

Clinical Record

- (4) There are no localizing signs, but a VIth nerve paresis on the side of the lesion is often present
- (5) Lumbar puncture shows a clear cerebrospinal fluid with a pressure of over 300 mm. The quantity is abundant, and there is no excess of protein

The majority of writers have since agreed that the disease nearly always occurs under twenty years of age, although there is a record in a man of twenty six ⁸

Both Asherson⁷ and Williams⁶ record this disease existing with another intracranial disturbance, Asherson describing it as associated with an encephalitis, and Williams with a brain abscess

The other points of Symonds's summary have not been disputed with one exception that it is generally agreed that the spinal fluid is not abundant, and that this apparent abundance is due solely to the increased pressure

Ventriculography has shown a normal system in the majority of cases and there is no evidence of an external hydrocephalus. The differential diagnosis is usually a brain abscess, but the comment of the neurologist in this case that he wished for a ventriculogram to be done to exclude a medulloblastoma, is interesting

Asherson makes the pertinent comment that the diagnosis is made in retrospect and there is no record of an early mistake in diagnosis

The pathology is generally agreed to be an obstruction to the venous circulation of the brain by a thrombosis

Symonds suggests that a partial thrombosis of the lateral sinus is the most frequent cause, the thrombosis spreading to the superior longitudinal sinus ¹⁰

Post mortem examination has supported this theory but it cannot be the complete explanation, as the disease is unusual whilst thrombophlebitis of the lateral sinus happens fairly often

I must thank Dr A. A. Cunningham Medical Superintendent at Kingston County Hospital, for permission to record this case and I must also thank Mr. Wyllie McKissock for his kindness in allowing me to quote from his letter and from his case notes

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CLINICAL NOTES

SOUND CONDUCTION THROUGH THE STERNOMASTOID MUSCLE IN MIDDLE EAR AND NERVE DEAFNESS

By DENYS E. HOWELLS* (London)

FROM personal observation and interrogation of normal patients it was found that if the sternomastoid muscle be placed on the stretch by turning the head towards the opposite shoulder, longitudinal stroking of the skin over the muscle with a finger would produce a low pitched sound. Should the whole length of the muscle be stroked systematically starting from the nape of the neck and working forwards the subject was aware of a point on the skin at which the sound was at its greatest intensity. That point was situated at the anterior border of the muscle about one inch below the mastoid tip.

Persons with normal hearing or with middle-ear disease could localize such a point within a few seconds of the investigation being started. A patient suffering from inner-ear or nerve deafness was unable to detect any sound when the skin was stroked and hence could not localize any such point.

In a series of cases, audiometer readings were taken to confirm the type of deafness. In addition a further reading was taken in those cases with normal hearing or middle-ear disease. The stimulator of the audiometer used for bone conduction was placed on the point of maximum sound intensity, i.e. one inch below the mastoid tip on the anterior border and both ears were plugged to exclude air conduction.

It was found that such a curve formed a shadow of that of bone conduction having ten decibels more loss at a given pitch than that due to stimulation at the mastoid process. At all other points on the sternomastoid muscle the difference in the audiometer reading was greater than ten decibels and in most cases the difference was so great as to make the construction of a curve impossible.

Mechanism

It appears that the transmission of vibration depends on simple conduction through the stretched muscle and cranio-cochlear conduction from the point of attachment of the sternomastoid muscle. The fact that the point of maximum intensity is situated on the anterior border one inch below the mastoid tip can only be explained by assuming some intrinsic resonating property at that point. The point does not correspond with any anatomical landmark such as the junction of the sternal and clavicular heads of the muscle nor does the distribution of fibrous tissue in the muscle substance offer an explanation.

Application

The longitudinal stroking of the stretched sternomastoid muscle provides a simple and speedy means of differentiating between middle-ear and nerve deafness without the use of such instruments as a tuning fork or audiometer. A patient suffering from nerve deafness fails to hear the vibrations and hence cannot localize a point of maximum intensity. A case of middle-ear disease will present a loss of hearing but will be able to appreciate the stroking of the skin over the muscle and will demonstrate it by being able to indicate a point at which the stroking is loudest.

* From the Ear, Nose and Throat Department, University College Hospital.

EXTENSIVE LUMBAR PUNCTURE AS A TEST OF DIFFERENTIATION BETWEEN REVERSIBILITY AND IRREVERSIBILITY BY LABYRINTHINE FENESTRATION OF OTOSCLEROTIC DEAFNESS

By F. KOBRAK (London)

MAX MEYER has shown (*Pract Otol*, I, and III) that extensive occipital puncture can bring about a considerable improvement of hearing in otosclerosis (and also in cochlear deafness). The method did not find due interest amongst the otologists who were and are concentrated on labyrinthine fenestration. Writer suggests that the combination of both methods might be worth consideration with the slight modification that the less popular occipital puncture is substituted by the, according to Max Meyer, less efficient, but for our purpose sufficient extensive lumbar puncture.

The intricacy of labyrinthine fenestration consists not only of the delicacy of surgical technique, but perhaps even more of the difficulty in the proper choice of suitable cases. Often it seems to be not easy to say, how much the barred entrance of the sound waves to the inner ear, how far intra labyrinthine changes are the source of deafness. If, apart from the sound conductive obstacle at the oval window, only abnormal intralabyrinthine pressure is the cause of high pitch deafness, and not yet degenerative changes in the organ of Corti, improvement of high pitch deafness can be expected from labyrinthine decompression from the extensive lumbar puncture, and then also from labyrinthine fenestration. If, however, definite improvement of high pitch deafness fails to occur following extensive lumbar puncture, the prognosis can be regarded as doubtful indeed, in this case, the effect of fenestration is expected to be unsatisfactory by bringing about a more or less irrelevant improvement of only low pitch deafness and not of the pertinent high pitches of speech and conversational voice.

A further differential diagnostic outlook seems to emerge, as we obviously depend not only on auditory tests in our indication of labyrinthine fenestration. Also the behaviour of vestibular tests, especially on *minimal calorisation*, provides functional features which are probably of avail in the indication of labyrinthine fenestration.

This preliminary suggestion of a test by extensive lumbar puncture, based on possibly specific functional—auditory and vestibular—differences before and after the L p test will be more fully discussed, soon, in a paper on clinical otoclerosis with special reference to abnormal intralabyrinthine pressure.

Summary

The effect of extensive lumbar puncture is suggested as a test to discern reversible from irreversible cases of high pitch deafness in otosclerosis. The L p. test is based on the examination of auditory and vestibular functions before and after the lumbar puncture.

SOCIETIES' PROCEEDINGS

ROYAL SOCIETY OF MEDICINE—COMBINED SUMMER MEETING HELD IN BRIGHTON

June 27th, 1947

OTOLOGICAL SESSION

Chairman—H. V. FORSTER, M.C., M.B., Ch.B., M.Sc.
(*President of the Section of Otology*)

Discussion on the Association of Otitis Media with Acute Non-Specific Gastro-Enteritis of Infants

MISS WINIFRED HALL: Acute non-specific gastro-enteritis of infants, or the diarrhoea and vomiting syndrome, as it is also called, is recognized as a condition limited to the first twelve months of life. That is not to say that older children do not suffer from diarrhoea and vomiting, but the character of the disease and the behaviour of the patient are then quite different from what is seen in the infant. In infancy, the dominant feature of the severe case is the appalling dehydration, which may occur either with the primary disease, or as the herald of the onset of a parenteral infection. In the toddler and older children, dehydration is absent. Why this should be, we do not know. Whether we are dealing with a specific infection, bacterial or virus, but limited in its application to the first year of life, or whether it is something inherent in the gradually evolving economy of the young infant, has yet to be decided. Quite possibly it is a mixture of both factors. It is certain that the younger the infant, the more typical is the course of the illness, and after roughly 10 months of age the response of the child to its infection tends to approximate more and more to that of its elders. This means, therefore, that the approach of the doctor, which includes the otologists, to the problems of infantile gastro-enteritis must be quite different from his approach to illness in an older child.

In Table I the incidence and mortality of cases admitted to the North-Western Hospital in the different age-groups during the years 1942-47 are shown, and the falling off of admissions in the later groups is very noticeable. The table also shows the very marked improvement in mortality figures in

TABLE I
NORTH-WESTERN HOSPITAL

Year	0-3 months		3-6 months		6-9 months		9-12 months		Totals		Mastoid operations	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
1942	40	12	19	10	9	3	6	4	74	29	—	—
1943	51	7	52	10	31	2	13	—	147	19	12	5
1944	72	17	87	13	33	4	28	3	220	37	27	4
1945	106	23	113	12	64	15	47	4	330	54	24	9
1946	82	10	87	8	39	3	34	2	242	23	6	1
1947 to June 6)	54	6	44	3	33	—	22	2	153	11	—	—

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the later years In 1942 the mortality rate was 39 per cent In 1943 it dropped to 13 per cent In 1943 the otitis media figures were 40 per cent of all cases, yet you will notice that only 12 mastoid operations were done that year In 1945 there were 24 operations, in 1946, 6, while for the first six months of 1947 there have been none But, although both the otitis media rate and the mortality rate have fallen, the severity of the disease has in no way declined The improvement is entirely due to better methods of general treatment, plus earlier recognition and more vigorous treatment of associated parenteral infections

During the years 1942-47, I was attached to six hospitals in widely separated areas, and was therefore able to observe not only variations in the disease in the different localities, but also the results of varying pædiatric treatments Four of these hospitals were in London, and two at St Albans The total number of mastoid operations done during these years is 190, and several hundred more cases of otitis media were seen which recovered without operation

The work on these cases began originally with the theory that the condition was a primary mastoiditis with a secondary irritative gastro enteritis, a theory which has been postulated by various observers, and so in the early cases, all which failed to respond quickly to treatment proceeded to operation We had, therefore, two main ideas in mind (1) To determine whether in the acutely ill baby a mastoid infection was always to be found, (2) To find out whether operation did or did not bring about improvement

We soon found that the idea of a primary mastoid infection was untenable By no means all severely ill babies even have an otitis media But in those cases which had a mastoiditis, particularly where frank pus was found, improvement after operation was immediate and often dramatic

In small babies the textbook signs of acute mastoiditis are completely absent There is never any redness or swelling, and as a sick baby cries with any handling, it is quite impossible to know whether tenderness is present or not The head-rolling sign, so often quoted, is quite unreliable, and so is enlargement of the posterior cervical group of glands The drumhead signs can also differ from those of acute otitis in an older patient, due to differences in the anatomy of the infantile ear It is advisable, therefore, before going on to the clinical aspect to consider these anatomical peculiarities, and the resultant difficulties in examination

Anatomical Points

One of the most important points is that in the infant the meatal canal runs downwards and forwards at an inclination of 35 degrees, so that in introducing a speculum one sees first of all the posterior and superior parts of the drum, and to see the anterior portion, it is necessary to tilt the speculum quite considerably Ignorance of this can be a very real pitfall for those unaccustomed to the infant ear Another point is that the calibre of the canal varies from the extremely narrow to the respectably wide, a variation peculiar to the individual, and in no way connected with his age

In Lederer's "Diseases of the Ear, Nose and Throat" (1946 ed, Philadelphia), we are told that in order to see the drum the speculum must be inserted until it nearly reaches the membrana This is quite unnecessary, and will

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only cause damage to the meatal wall and drive the wax which is always present down on to the drum. A small speculum, carefully inserted and moved so as to show all parts of the drum in turn is all that is required. Wax is always present in the meatus in varying amounts. It must be completely removed before an accurate picture of the drumhead can be obtained, and this can be a very slow and difficult procedure. I personally use either a specially made fine hook, with a carefully rounded end, or the wool-carrying end of a very fine Jobson Horne wool carrier.

Contrary to the textbook statements the normal infant drumhead should show a properly formed light reflex, after about 6 weeks of age. It is usually shorter and fatter than in an adult, but it is quite definitely present, and absence means that the drum should be watched. Absence is not an indication for myringotomy, but it will be found that as the child returns to normal, so the light reflex reappears. I think that the reason why it is so often said to be absent in the infant is due partly to the anatomical difficulty of seeing that area of the drum, and partly to the difficulty of completely removing the wax. It is very easy to mistake a thin colourless deep-lying sheet of wax for the drum.

The tympanic membrane of an infant is said to be thicker than in later life. This is only so in the very young infant of the 1 to 6 weeks age-group; it is certainly not so in older babies. In the early days when we were doing many myringotomies as diagnostic measures in cases of unexplained pyrexia, or persistent toxæmia, one sometimes went through a thick opaque membrane, and had a dry puncture, while in other children of the same age-group, the drum would be quite thin, and the knife go through with the characteristic sound and feel of parchment. There does not seem to be any definite age when the change in character of the drum takes place; it seems to be an individual matter. The thick drums do not, of course, show a light reflex.

In the young infant there persists an undifferentiated mass of mesenchymal tissue in the upper part of the middle ear, often with trabeculae passing downwards to other points in the cavity. This mass partly shuts off the lower and anterior parts of the middle ear, and it is quite possible that it accounts for at least some of the cases of mastoiditis with an apparently normal drum. These cases, by the way, are not common, but they do occur, and the possibility of a completely "silent" mastoid must be remembered when searching for the cause of a persistent pyrexia, or a sudden collapse. It probably does account for the frequency with which one meets a suppurative otitis media confined to the upper and posterior part of the tympanic cavity. The auriscope appearances in such cases are typical. There is an elongated red shining bulge along the posterior meatal wall, more marked above than below. On looking round, the drum proper appears to be lying on a much deeper plane, and often appears perfectly normal, even to the possession of a light reflex. The inexperienced observer is apt to assume that he is looking at a posterior wall furuncle. Actually the forward bulge of the posterior part of the drum carries with it the adjacent part of the posterior meatal wall, and it is often very difficult to make out where one ends and the other begins.

The appearance of the inflamed drumhead may vary from a faint greyish-red flush either at the margin, or spread over the surface, to the typical bulging

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bright red drum Sometimes a tense collection of pus gives the drum a characteristic opaque grey colour, and full appearance A pink, or red flush without fullness is not usually an indication for myringotomy, with adequate treatment such a drum may return to normal It does indicate an incipient infective process that needs watching I would consider the indications for myringotomy to be (1) A localized grey or red posterior bulge, (2) A generalized red bulging drum, (3) A grey opaque bulging drum, and (4) A red flushed drum without fullness, but associated with pyrexia or an exacerbation of the general symptoms

In the infant, the eustachian tube is short and straight Cases have been recorded where milk has been found in the middle ear cavity at operation It is therefore important clinically that the babies should not be fed lying on their backs

My first group of cases occurred in the latter part of 1942 at Oster House E M S Hospital, St Albans At that time ordinary otitic conditions were very prevalent, and when our first cases showed a purulent otitis media early in the illness, and rapidly went on to operation with positive results, it did look as though the gastro enteritis was merely the infant's way of responding to an otitic invasion But as the series proceeded, and I began to extend my observations to other hospitals, it soon became obvious that this was not the case, and that the otitis was only an incidental factor in the disease The onset of other parenteral infections produced exactly the same gastro enteritic reactions as did the otitis

The Oster House children were all examined aurally on admission An abnormal drum was incised as soon as it appeared Intravenous drips were used for the dehydration, but if no improvement occurred in forty eight hours we proceeded to a bilateral mastoidectomy The reason for this was as follows We found that in almost all cases of true infection, both mastoids were involved, and, further, the contents of the mastoids often bore no relation to the appearance of the drum Often what appeared to be the better ear had the worse mastoid on operation

Because of the absence of typical signs, the diagnosis of a mastoid infection and the decision when to operate can be extremely difficult One of the most trying things from the surgeon's point of view is the way in which a purulent otitis will dry up It is quite common to find a bulging drum, obtain pus on myringotomy with relief to the symptoms, and then have another general relapse in a few day's time On examination the original incision is soundly healed, and the drum again red and bulging In the early days I would have operated with such a history Nowadays, I would not unless the child's condition continued to deteriorate in spite of treatment I think that a certain amount of pus must escape down the eustachian tube, and after the immediate tension has been relieved by a myringotomy, the drum will therefore heal If, later on, another sudden collection of pus occurs, the process is repeated The myringotomies do not seem to have any untoward after-effects, and it is not necessary to open the mastoid after two or even three incisions, unless the general condition fails to respond It must be remembered that a collection of pus in the middle ears can appear quite suddenly, and be accompanied by equally sudden symptoms Within a few hours a normal drum can become

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only cause damage to the meatal wall and drive the wax which is always present down on to the drum. A small speculum, carefully inserted and moved so as to show all parts of the drum in turn is all that is required. Wax is always present in the meatus in varying amounts. It must be completely removed before an accurate picture of the drumhead can be obtained, and this can be a very slow and difficult procedure. I personally use either a specially made fine hook, with a carefully rounded end, or the wool-carrying end of a very fine Jobson Horne wool carrier.

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The appearance of the inflamed drumhead may vary from a faint greyish-red flush either at the margin, or spread over the surface, to the typical bulging

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long should be made close to the post-auricular sulcus, and well above the mastoid tip. A longer incision than this only exposes an unwanted area of bone, and provided a sufficiently small retractor is used, the exposure is adequate. The subsequent scar is practically invisible, whereas if the usual long curved incision is made the result is both obvious and ugly. The bone must be opened widely, mere drainage down to the antrum is not enough. I have seen cases where this has been done without relief, and subsequent reopening showed extensive disease still present. The anatomical findings in these mastoids vary considerably, but it is evident that pneumatization can occur at a much earlier age than is taught. I have seen a completely pneumatized mastoid at 4 months old. The zygomatic cells seem to be the first to appear, and the apical cell the last. I have seen pneumatization in the zygomatic area at 4 weeks old.

I do not suture the wounds at all, but pack with half-inch ribbon gauze steeped in kat-iodine and parasepsin emulsion. Parasepsin is active against the usual pyogenic organisms, while kat-iodine, an electro positive solution of iodine, is said to be active against the Gram negative group, particularly the coliforms. This is most useful because of the frequency with which the latter appear either as contaminants or as active agents.

In that early series at St Albans, we went very largely on failure to respond after forty-eight hours. All the babies were gravely ill on admission. The first 2 cases were not operated on, but at post-mortem the mastoids contained pus. The first 9 cases were done under general anaesthesia. 2 died with persistence of toxæmia and dehydration. Of the others, 4 made rapid and satisfactory recoveries after operation, the remaining 3 were held back by other infections, which in 2 of them was a post-operative pneumonia. Looking back on these cases one is struck by the fact that they were all cases of otitis media and mastoiditis from the beginning. That has by no means been the case in other series, presumably the organisms then responsible had a strong affinity for the ear. Taking all my cases, it is obvious that the idea of a primary otitis is quite untenable. In 1943-44, the otitis media rate at the North-Western Hospital was 40 per cent of all cases. In 1945, the figures at the North-Eastern Hospital were 16 per cent, and in 1946 29 per cent. Although these are two different hospitals, they are all London cases, and the figures were compiled by the same observer. The fall in the number of ear infections is particularly interesting when one finds that the incidence of other parenteral infections, notably pneumonia, has not shown a corresponding fall.

Table II, which has been provided by Dr M. Alexander of the North-Eastern Hospital brings out this point very well. It shows that in 1945,

TABLE II
NORTH EASTERN HOSPITAL

1945 admissions	Associated with dehydration			Not associated with dehydration			
	On admission	After admission	Total	On admission	After admission	Total	Total cases
Parenteral inf	53	27	80	70	29	99	= 179
Ot media	10	8	18	9	10	19	= 37
Myringotomies	8	6	14	9	10	19	= 33
Mastoids	—	1	1	—	1	1	= 2

On admission = within seven days of commencement of illness

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while there were 179 cases with some other form of parenteral infection, mostly pneumonias, there were only 37 cases of otitis media.

There is another very interesting parallel to this fall in the otitis media rate. In 1943 there was a big measles epidemic, associated with a very high otitis media rate. In the 1945 epidemic the otitis rate was low. This suggests very strongly that the otitic incidence in gastro-enteritis is a variable quantity, and fluctuates as the incidence in other diseases. In other words, if in any given year there are at large a number of virulent organisms with a predilection for the ear, there will be a high otitis rate in diseases such as gastro-enteritis whose mode of onset is usually so devastating that the child's resistance is completely knocked out. If the attack is severe, these babies on admission are in a state of acute shock, and it is reasonable to assume that they are thereby rendered more vulnerable to whatever type of secondary infection happens to be about at the time. No doubt this variation explains why surgeons who have only recently begun to deal with these babies are not finding the mastoid infections that they had expected. Another point is that the death-rate has steadily declined. In 1942 at one hospital it was 39 per cent. ; in 1946 it was 9.5 per cent. Table III shows this very clearly.

TABLE III
NORTH-WESTERN HOSPITAL

Year	Total admissions	Deaths	%	Mastoid operations	Deaths
1942	74	29	39	—	—
1943	147	19	12.9	12	5
1944	220	37	16.8	27	4
1945	330	54	16.3	24	9
1946	242	23	9.5	6	1
1947 (to June)	153	11	7.1	—	—

My largest series of operations at any one hospital was at the North-Western Hospital, with 69 cases for the period 1942-47. In this series there were 50 recoveries, and 19 deaths, an operation mortality rate of 27 per cent. The cases have been classified according to the operation findings. Positive findings mean frank pus. Plus-minus means hyperæmia, or a little sticky mucus. Negative means that the ear was apparently normal. All cases had both ears opened, and the classification refers to the worse ear. As both ears were opened deliberately, irrespective of the signs, there were a certain number in which one ear was negative, but as I have already said one should never omit examination of a doubtful ear. The fact that nearly all the mastoids are bilateral is extremely interesting, and taking into consideration those cases where the infection is limited to the posterior part of the drum, there may have been in some instances at least a blood-stream infection.

Table IV shows the cause of death in the 19 fatal cases. In 10, there were

TABLE IV

19 deaths		+Operation findings, 6
Causes	Toxæmia	±Operation findings, 3
		-Operation findings, 1
	Pneumonia, 6 (all operation findings +)	
	Septicæmia, 3 (one with meningitis) (operation findings +)	

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no P M signs other than those of extreme toxæmia. In only one of these was there no operation evidence of otitis. The others died in spite of operation, the original infection in the toxæmic deaths, or the other parenteral infection in the others being presumably too severe to be overcome by drainage of the mastoids. It does not appear either, in looking through the notes that earlier operation could have saved the children. There is no evidence of undue delay. The post-operative progress varied. In some of the cases there was a short initial improvement, followed by a sudden collapse and rapid decline, in others there was no improvement, the child merely went on steadily deteriorating, with persistent gastro enteric symptoms.

Of the 50 recoveries, 3 had completely negative findings, and can be ignored. 22 made quick and convincing recoveries, while 25 recovered slowly. The 22 good cases all had mastoiditis as their only parenteral infection. 19 of them had frank pus in the mastoids. 3 of them merely showed a bony hyperæmia, but the improvement after operation was quite as rapid and convincing as in the others.

Of the 25 slow cases, 2 had to have the mastoids reopened to drain a residual area of infection after which improvement was rapid. Of the other 23, 12 had a second parenteral infection, usually pneumonia, while in 11 no parenteral infection could be found, and the patients merely recovered slowly, with gastro intestinal relapses of varying severity.

On the whole, figures from other hospitals agree with these. The number of negative findings was greater in the early days when we had less experience in the proper selection of cases for operation.

The conclusion to be drawn from this series is that where otitis is the only complication, an immediate and convincing recovery is to be expected. The first signs of recovery are cessation of the diarrhœa and vomiting, and no more dehydration, though this takes a little longer to disappear. Delayed recovery after positive operation findings means either a second parenteral infection, or a degree of toxæmia too severe for the child to overcome except with difficulty.

The bacteriology of these cases is varied and confusing. Unless a secondary parenteral infection is present, many of the children go through their illness, and either die or recover without any organisms being found to account for their condition. True, they nearly all have inflamed throats, but the fact that something can always be recovered from the nasopharynx is no proof that the extremely varied and changeable flora there is responsible for the illness. Bacteriological examination of the stools and vomit has proved negative. The organisms found in the mastoids rarely coincide with those found in the throat, or even with each other. It is not at all uncommon to grow, for example, a streptococcus from one mastoid, and a pneumococcus from the other. I remember one child who grew a pure culture of *Str viridans* from her throat. One mastoid gave a pure culture of the *Str hæmolyticus*, and the other a pure culture of pneumococci. The child herself had a *Str viridans* septicæmia.

The coliform bacilli play a very variable part. When a genuine pyelitis is present—not a common complication—they are usually responsible. They are often present in the nasopharynx, and are a very common contaminant on the skin surrounding the mastoid area. Hence the uselessness of penicillin

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as a local post-operative measure. Used by itself systemically, penicillin has been disappointing in the past. It has no effect on the gastro-enteritis itself, and will only control parenteral infection in the absence of the coliforms. We had an unpleasant instance of this at St. Albans. When penicillin first became available it was given to the gastro-enteritis cases. Unfortunately the administration coincided with the appearance of an extremely virulent strain of *B. coli*. 5 of the babies died, and we discovered too late that they were all *B. coli* septicæmias. I saw some similar cases at my other E.M.S. hospital, and there were also 2 cases at the North-Western Hospital. These 2 were fortunately discovered in time, and with sulphonamides the children recovered. The reason for the poor results with penicillin formerly, apart from coliform infections, appears to have been inadequate dosage. When the drug was first in use, 20,000 units four-hourly were considered a full dose for a 6-months-old baby. Nowadays one would give much more than that: 100,000 units six-hourly is quite a usual dose, and the response is correspondingly better.

Of the sulpha drugs all have been tried, and sulphathiazole and sulphadiazine seemed the most useful. It should be remembered that the infants' toleration for these drugs is much greater proportionately than that of the adult, and they can take surprisingly large doses. A combination of penicillin and a sulpha drug will give better results than either singly, particularly in the presence of coliforms.

Anæmia can be severe, and may greatly delay recovery. A small transfusion of whole fresh blood immediately after operation may make all the difference to the child's response.

Various investigators have suggested other sources of infection as the origin of the illness, for example the sinuses, particularly the posterior group. Others have found an œdematous condition of the brain and meninges, and have suggested that the condition is primarily an encephalitis. I have no personal knowledge of sinus findings, but cannot believe that a sinus infection is any more likely to be a primary condition than an otitis. As for the so-called encephalitis, physicians in this country, while agreeing that an œdematous appearance is often seen post-mortem, do not consider that it is a true encephalitis, or that it has any causal significance.

SUMMARY

We still do not know the cause of acute infantile diarrhoea and vomiting. It is not bacterial, and it is not a primary mastoiditis. Many workers suspect a virus, a very tempting theory, but one which still has to be investigated. Mastoiditis undoubtedly occurs as a complication, and when the only one, response to operation is rapid and conclusive. The signs of acute otitis and mastoiditis differ in the infant from those seen in an older patient, but the effect is much more devastating, and the absence of redness and swelling must not be taken as an indication of a mild infection. If it is not treated promptly, the child will die before the stage of redness and œdema is reached.

One theory of the diarrhoea and vomiting is that it represents a "trigger response" to some stimulus. The initial one may be a virus or some other unknown quantity, but the response once started can then be elicited by any subsequent stimulus, of which otitis media is one. It takes very little to set

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the syndrome off once the illness has started, and a mild otitic infection could certainly do so, but a mild otitis does not as a rule go on to a mastoid infection.

An interesting point about this trigger-like irritability is that it seems to persist for some time even after apparent cure, and a baby discharged from hospital as perfectly well may be back in a few days' time as bad as ever.

Repeated myringotomy, or operation does not appear to have any ill effect on the hearing, unless operation has been delayed too long, in the presence of a severe infection.

I only know of two cases of severe deafness following mastoiditis, and in both of these there was an extensive bilateral purulent infection which, because of the absence of local signs, was not recognized as mastoiditis until the occurrence in one case of a facial palsy, and in the other a meningitis, superimposed upon a profuse persistent ear discharge led to the summoning of an otologist. Both these children are now at a school for the deaf.

POSTSCRIPT

The peak years for my cases were 1943 and 1944. In the first half of 1947 I saw very few cases of otitis media, and did no operations. But now, in December, it would appear that we are about to experience another upward swing in the otitis media rate. There has been a marked increase in the number of otitic cases in the last two months, and in their severity. As the occurrence of otitis media in gastro enteritis is definitely seasonal, being at its height at the same time of year as otitis in other complaints, this strongly suggests that this winter is going to show a large number of ear complications. What effect present day paediatric treatment plus the administration of sulphadiazine and penicillin will have on the incidence of mastoiditis remains to be seen.

I should like to express my thanks to all my colleagues whose cases have formed the basis of this paper, particularly Dr William Gunn of the North-Western Hospital, and Dr M. Alexander of the North Eastern Hospital, whose notes and statistics I have used.

MR JOHN E. G. MCGIBBON. In view of Miss Hall's comprehensive account of the *syndrome of acute otitis media, latent mastoiditis and diarrhoea and vomiting in infants*, I propose to base my remarks on observations made on a series of patients who have been under my own care during the past sixteen months.

Incidence. The frequency of infection of the middle ear tract in infants is still not appreciated, and until recently the most striking evidence of the prevalence of such infection came from the post-mortem room.

EBBS' (1937) figures are frequently quoted. He stated that 368 (61 per cent) of 603 infants who died whilst suffering from diarrhoea and vomiting were found at autopsy to be suffering from a purulent infection of the middle ear cleft.

Coupar and McConkey (1937) found that, in 1936, of 1,324 infants under 1 year of age admitted to Alder Hey Children's Hospital, Liverpool, 195 (14 per cent) suffered at one time or another from otitis media or otitis media and mastoiditis and an analysis by Derham (1947) shows that 240 (21.6 per cent) of 1,107 infants admitted to the hospital in 1946 were suffering from aural infection when first examined, and that 191 (17.2 per cent) developed a

There is evidence that in both sporadic and epidemic cases of infantile gastro-enteritis changes are found in the brain which are characteristic of an infection by a virus

(b) *Parenteral infections* (3, Fig 1) such as otitis media, pneumonia, pyelitis, cellulitis, erysipelas, etc

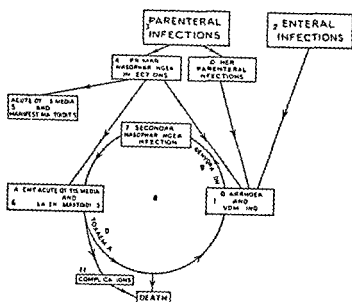


FIG 1
The syndrome of acute middle ear cleft infection mastoiditis and diarrhoea and vomiting in infants

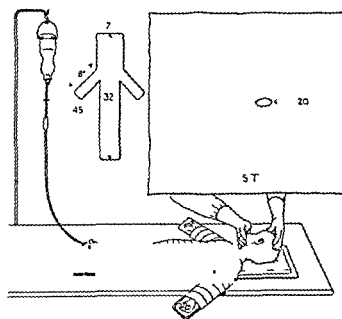


FIG 2
Diagram of special splint and towel ST—special towel 48 in x 52 in (See p 412)

In 1930 Marnott wrote in the introduction to his book that "Many of the disturbances of infants which have previously been attributed to dietary faults are in reality the results of infection" and that "the most frequent infections that interfere with nutrition are otitis media and pyelitis" and it is now generally recognized that vomiting and diarrhoea may occur in infants suffering from any acute infection

Otitis media and mastoiditis Infection of the middle-ear cleft is usually secondary to nasopharyngitis, and it is caused either by direct entrance of organisms along the eustachian tube—some observers have stated that they have found ingested milk in the mastoid antra—or by lymphatic spread

If blood-borne infection of the middle-ear cleft does occur in infants, the number infected in this manner must be very small

Nasopharyngitis may be due either to

(a) *Primary* upper respiratory infection (4, Fig 1), which in the infant sometimes may be so slight and transitory as to escape recognition

This may give rise to *manifest* acute otitis media and manifest mastoiditis (5, Fig 1) with swelling and redness over the mastoid process, which is an infrequent occurrence. It is a benign condition which causes little constitutional disturbance and which is cured by operation

Or it may give rise to *latent* otitis media and *latent* mastoiditis (6, Fig 1) which will be described later

(b) *Secondary* infections (7, Fig 1) caused by organisms deposited in the nasopharynx by vomiting and/or regurgitation

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TABLE IV

BACTERIOLOGICAL FINDINGS OF THE MASTOID ANTRA IN 99 CASES OF INFANTILE MASTOIDITIS

Organisms	Posterior drainages		Undiagnosed	Totals
	67			
	Recoveries 36	Fatalities 31		
Sterile	4	9	1	14
<i>Staph. aureus</i>	14	5	1	20
<i>Staph. aureus</i> and non-hæm. streps.	—	—	1	1
<i>Staph. aureus</i> and <i>Staph. alb.</i>	1	—	—	1
<i>Staph. aureus</i> , proteus and <i>Strep. faecalis</i>	—	—	1	1
Pneumococci	1	2	4	7
Pneumococci and proteus	1	—	—	1
<i>B. coli</i>	5	6	5	16
<i>B. coli</i> and <i>Staph. aureus</i>	1	—	—	1
<i>B. coli</i> and pneumococci	—	2	4	6
<i>B. coli</i> , <i>Staph. aureus</i> and <i>Strep. faecalis</i>	—	—	1	1
<i>B. coli</i> and <i>Strep. faecalis</i>	—	—	3	3
<i>B. coli</i> and diphtheroids	—	1	1	2
<i>B. coli</i> and non-hæm. streps.	—	—	1	1
<i>B. coli</i> , non-hæm. streps. and diphtheroids	—	—	1	1
<i>B. coli</i> , hæmolytic streps. and diphtheroids	—	1	1	2
<i>B. coli</i> , and <i>Staph. alb.</i>	—	—	1	1
<i>B. coli</i> and <i>B. influenzae</i>	—	—	2	2
Hæmolytic streps.	1	1	—	2
<i>Staph. albus</i>	6	2	—	8
<i>Staph. alb.</i> and diphtheroids	1	—	—	1
<i>Staph. alb.</i> and Friedländer	1	—	—	1
<i>Staph. alb.</i> and proteus	—	1	—	1
<i>B. proteus</i>	—	—	2	2
Hæmophilus group	—	1	—	1
Findings unknown or not cultured	—	—	2	2

It is interesting to note that only in 50 per cent. of the cases similar organisms from the meatus and mastoid antra were cultured.

The organisms found by culture from the antra are shown in column A of Table V, and I have compared them in column B with the bacterial findings in 92 cases of acute suppurative otitis media, *not* in infants, quoted by C. P. Wilson (1946). Both of these series occurred in the same period—i.e. 1945-46, so they are strictly comparable.

TABLE V

A (McGibbon)		B (Wilson)
Infants with gastro-enteritis (99 cases)		Non-infants (92 cases)
<i>B. coli</i> alone or with other organisms	36 (36.3%)	Nil
<i>Staph. aureus</i> alone or with other organisms	25 (25.3%)	19 (20.6%)
Pneumococci alone or with other organisms	14 (14.1%)	18 (19.5%)
Hæmolytic strep. alone or with other organisms	4 (4.0%)	46 (50.0%)
Others	16 (16.1%)	6 (6.5%)
Sterile	14 (14.1%)	3 (3.2%)

Of the infants submitted to posterior drainage the best results were obtained in those from whom *Staph. aureus* were obtained by culture.

The fourteen patients from whom sterile cultures were obtained had all been subjected to intensive chemotherapy and systemic penicillin, which may have been the cause of the absence of bacterial growth.

When the pus was present it was usually of a thick tenacious nature.

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In all cases except two, the naked-eye pathology was confined to the mucoperiosteum, and the lesions observed were congestion and/or oedema of the mucosa and the presence of serous or purulent fluid

In two patients only was there an obvious osteitis. Sections of bone were not made and the impression gained was that the antrum was a cesspool of pus which did not kill by toxæmia but by causing a persistence of the diarrhoea and vomiting (see Fig 1)

The absence of bone disease is borne out by the investigations of Causee (1946). He sectioned seventeen mastoid bones of 13 athreptic infants with mastoiditis and found no involvement of bone by infection

Treatment *General treatment* is a paediatric problem, and the amount of time, effort and skill in this respect that has been spent by the Resident Medical Officers and Nursing Staff on these patients had been unbounded

There is one point that I would stress in regard to general treatment, and that is the importance of active measures to restore the fluid content of the body by the intravenous route—in dehydrated infants this is a most valuable pre- and post-operative measure, in some cases the infusion of whole fresh blood appears to be a life-saving procedure

Systemic penicillin and sulphonamides do not appear to have any beneficial effect

Local treatment If an infant with abnormal drumheads suffering from diarrhoea and vomiting fails to respond to general treatment, myringotomy should be performed

In very many cases this marks the turning-point to recovery

Sometimes there may be an audible "pop" on incision of the drumhead which Le Mee (1937) considers to be due to air rushing into the tympanum but in the presence of gas-forming organisms it may be due to the gas rushing out

The products of myringotomy in 61 of the 67 cases operated on were as follows

(1) *Dry incision* in 5 cases (8.2 per cent) A dry myringotomy may be due to (a) dehydration—such a dry middle ear will discharge when the fluid balance of the infant is restored, or, as mentioned earlier, it may be due to (b) obstruction of the aditus by swollen mesenchyme

(2) *Blood only* in 8 cases (13.1 per cent) This may conceal any other fluid that may be present, or

(3) *Serous fluid or pus* in 48 cases (78.7 per cent) This was the most frequent and satisfactory finding

Preliminary myringotomy was performed in 61 of the 67 patients operated on by posterior drainage, and in 15 of these the drumheads were incised on more than one occasion

After reviewing the cases, I am of opinion that valuable time may be lost by repeated myringotomies, as 10 cases (66.6 per cent) of the 15 submitted to more than one myringotomy died, and I consider that if an infant does not improve within twenty-four hours after preliminary myringotomy, the mastoid antrum should be drained by the posterior route

Posterior drainage is a simple operation carried out under local anaesthesia, after premedication with chloral and bromide

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found in one mastoid or in both, and they were assured by the physicians and sisters alike that there had been immediate improvement. The cases which really troubled them were those in which they opened the mastoid and found nothing, and the baby started to get better. No one knew why—whether or not it was due to the new interest in the child—but it did happen.

He would not be prepared to say that infection alone in the ear could cause gastro-enteritis—he had seen so many babies with acute otitis media with not the slightest sign of gastro-enteritis. He had opened many acute mastoids in infants in whom there was no gastro-enteritis. He thought that mastoid infections were likely to occur in any debilitated baby that was vomiting as it lay on its back. In such a position some of the vomit passed into the short wide eustachian tubes, and he had actually seen milk in the mastoid antrum. When an infection did occur in the ear, as he had said, it made the child's gastro-enteritis worse. Sometimes they responded to incision of the ear drum, at other times to opening of the mastoid. It seemed quite certain that babies with diarrhoea and vomiting should have their ears examined daily. Any sign of inflammation in the drums called for paracentesis. He did not think the mastoid should be opened if there were no signs of inflammation in the ear. They had to go on such clinical signs as were apparent, and he would be doubtful about doing this operation just on the chance that some infection might be there.

MR. ERIC WATSON-WILLIAMS said that in the last fifteen years he had seen rather less than 100 of these children. But he was quite convinced that a proportion of these had infective material in the antrum, and some of these children who seemed desperately ill certainly did recover after the infective material had been given artificial egress. Further than that he found it difficult to go. He rather supported the view that every reasonable measure that might tend to turn the scale should be undertaken. Mastoid opening in a small infant was not an operation of great severity. It was a matter literally of minutes—of very few minutes in fact—and he liked to feel that, unless the baby was over six months, he could complete the operation well inside five minutes. There ought not to be much shock.

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case, and he had found otitis much oftener than Miss Hall. This difference was interesting and might be due to the conditions under which Mr. McGibbon worked and might correspond to the practice as they saw it in the Children's Hospital at Birmingham, where the physicians and paediatricians were in charge of their patients, where there was a constant watch on the drumhead, and where they did their best for the patient, but called in the otologist to carry out the necessary treatment the moment there was any doubt about the ear.

The most important point was the time of intervention. It was highly disadvantageous to open the mastoid too early or too late—if too late there was secondary general infection and the case was hopeless.

MR. G. A. FRASER said that they had had a rather severe outbreak of infantile gastro-enteritis in the Brighton area recently, and Mr. Allen and himself had had a very worrying time deciding upon which children they should do a mastoidectomy. During the last year 27 bilateral mastoidectomies were performed on babies suffering from gastro-enteritis. In half of these cases there were signs of middle-ear disease, but the other half showed no clinical signs of middle-ear or mastoid infection, and these cases were operated on only after a great deal of pressure from the physicians. The striking thing was that of the 27 cases operated upon only two were found to have perfectly healthy mastoid processes.

MISS WINIFRED HALL, in reply, said that most of her cases had been in the L.C.C. fever hospitals, where the majority of London gastro-enteritis cases were now sent, in preference to the general hospitals. Although a certain number of mild cases were sent in, the majority were very acutely ill, and while she could not give figures, it was quite certain that the fall in the death-rate was due to improved treatment, and not to a greater number of mild cases. She was strongly of opinion that the mortality of the disease had a great deal to do with the paediatric treatment, and the greater the experience and care of the paediatrician and nursing staff, the better were the results. In one hospital showing very good results the medical officer in charge of the wards had been dealing with nothing but gastro-enteritis for the last four years.

Mr. Crook's point about the immediate and surprising improvement sometimes seen in babies with negative operation findings was important; she had seen it several times. Yet, in other apparently similar cases, there would be no improvement, and the child would die. She did not know any reason for this improvement. She had not found any laboratory procedures of help in making a diagnosis; she went on the lines given in the paper. Also when one had seen a number of these cases, one acquired a sixth sense about them which was quite as helpful as any sign. The white cell count was notoriously misleading. She did not know why in some cases of purulent mastoiditis an operation swab should be negative. It was not always due either to penicillin or to sulphonamides. It could occur in cases which had had neither. She had tried sending pieces of bone for culture, but even these were sometimes negative.

She did not use any form of splint at operation, merely wrapping the babies in a small blanket in the fever hospital method for tracheotomy. She had seen two cases of brachial palsy, fortunately only temporary, after the use of a splint, and was rather afraid of them. She thought myringotomy preferable

to puncturing the membrane with Gray's needle. The incision healed very satisfactorily, often in twenty-four hours, and even after obtaining pus, so that there was apparently no reason to fear its remaining as a future source of infection.

As regards periodicity, at the moment in London they seemed to be at the bottom of the swing, but it might at any time come up again, and there were signs that it was now starting to do so (December 1947). She was against exploratory puncture of the mastoid antrum, on the grounds that this would not relieve extensive disease which would need further opening, but chiefly because it would miss pus confined to one or other of the groups of cells, and so mislead the operator. She had had several cases where the zygomatic cells only contained pus, and an antral puncture would not have touched them. One of the two cases that needed reopening showed zygomatic infection, and when this was cleared out, the child promptly recovered.

MR. J. E. G. MCGIBBON, also in reply, said that in his hospital where there was a number of experienced medical officers, it was often difficult for them to arrive at an opinion as to the presence of mastoiditis on the appearance of the drumhead. Sometimes there was too much delay in calling upon an otologist to see the case, and he had heard of an infant who had four myringotomies in a period of about fifteen days. He felt very strongly that the babies who did not improve after myringotomy went down so quickly that they might be dead within forty-eight hours. The majority of the babies he saw were those in whom a myringotomy had not stopped their downward course. He thought that in such cases the mastoids should be opened within twenty-four hours and not left for forty-eight or seventy-two hours, by which time the baby might be dead.

June 28th, 1947

*Chairman—H. V. FORSTER, M.C., M.B., Ch.B., M.Sc.
(President of the Section of Otology)*

The Peep-Show Technique for Pure Tone Audiometry in Young Children*

DEMONSTRATION AND FILM

By M. R. DIX, F.R.C.S., and C. S. HALLPIKE, F.R.C.P., F.R.C.S.

*(Otological Research Unit, Medical Research Council, National Hospital,
Queen Square, London, W.C.1.)*

MR. HALLPIKE said that the test procedure to be described had been designed to solve the difficult clinical problem of the young child, under the age of 5 years, in whom backwardness was associated with failure of speech development. The failure might be due to deafness, to mental defect, or to a purely motor disorder of speech. The otologist was called upon for an authoritative opinion on the hearing, and here the question of a suitable test was a very difficult one. Ordinary speech tests were very difficult in the presence of deafness with defective vocabulary, while young children found pure tone audiometry very

* For a full description of the test procedure and equipment reference should be made to the authors' article in the *British Medical Journal*, 1947 (ii), 719.

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boring, and their responses were in consequence unreliable. A still greater difficulty attended the standard test procedure for pure tone audiometry, namely that before the test could be applied the child needed to be given and to assimilate an explanation of the nature of listening and hearing with the telephone receiver. This was often impossible. In designing the Peep Show procedure they had endeavoured to overcome these difficulties: first, by giving an arresting significance in the child's consciousness to the usually uninteresting pure tone stimuli, secondly, by so devising the test that the child was persuaded to respond to the sound stimulus with no explanation other than a very simple dumb show.

Mr Hallpike then demonstrated the test equipment and showed a short film of deaf children undergoing the test. He said that the method was of particular value between the ages of 3 and 6 years. With children of normal intelligence decisive results were nearly always obtained in the course of a single visit to the Clinic.

Miss Dix said that a vital point in the management of the children was that they should not be seen when tired or hungry. All cases were seen by appointment in a quiet room with their parents. It was essential not to attempt this in a busy Out-Patient Department. During the interview she played with the child while Mr Hallpike talked to the parents while observing the child and assessing its intelligence. Only when its co-operation had been secured in this way did they proceed to the Peep Show test.

Mr TERENCE CAWTHORNE said that he had the advantage of having seen this device in action and of providing Mr Hallpike with some deaf children to test. One of the most difficult problems in otology was a child under 5 who though obviously hard of hearing for speech, was able to hear certain sounds. It was important, in such cases, to make a reasonably accurate estimate of the child's hearing. It might be labelled as requiring psychological treatment, or for education at a deaf school when in fact it could quite well be educated with appropriate assistance with hearing children. Therefore any method of testing that gave a better and more accurate picture of the hearing capacity was of the greatest importance. Some of these children were very shy and would not respond to any form of sound at all and yet one felt that there was some hearing. With the Peep Show technique such children could be made to respond when all other methods failed.

He also wished to emphasize that the diagnosis of deafness in young children should remain within the province of the otologist. If he employed a technician to assist him the relationship should be the same as between radiologist and radiographer. They all knew that the best conducted radiological departments were those in which the radiographer was under constant supervision by the radiologist. In a highly critical technical procedure such as the Peep Show it was of paramount importance that the work should be under the supervision of an experienced otologist.

Mr C HAMBLIN-THOMAS said that this was a most useful piece of apparatus for the clinic. He wished they could get social workers at the clinics to assist in carrying out these tests and also in undertaking the follow-up of the children. It would be interesting to learn from Mr Hallpike whether the hearing which

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remained showed signs of developing under training—whether the children's perception improved to any extent.

He added that some audiometricians were being trained at the Metropolitan Throat Hospital, but their future depended on the possibility of their employment. It was of no use training girls if there was no future for them. He agreed that the otologist must be in charge initially and primarily, but if there were trained girls available they would be of great help to the otologist.

MR. IAN G. ROBIN said that he himself had not had such success with children under 5, but he thought the present instrument was most suitable for children between $3\frac{1}{2}$ and 5, and not suitable for most children of between 2 and 3. Here the Ewing technique played a very important part. He thought that the Peep-Show and the Ewing technique should have a place in all deafness clinics.

MR. M. L. FORMBY said that it would be a great mistake for them to feel that this was something which could be tacked on as an adjunct to a busy ear, nose and throat department and left to technicians to carry out.

MR. HALLPIKE agreed that it would be quite useless to have this kind of apparatus in a busy out-patient room, and to bring the child into such a place where other things were going on probably more interesting than the test. It was necessary to use the apparatus in a quiet room where there was nothing to distract the child's attention. Another practical point was that according to the terms of the Education Act of 1944 these children now become the responsibility of the Minister of Education *before* the age of 5. Therefore the diagnosis of deafness before the age of 5 was, for administrative reasons, more important than before. He agreed with Mr. Robin concerning the desirability of getting evidence of deafness before the age of 2. The Peep-Show was not suitable for this but it was, he thought, much the most effective means of obtaining a pure tone audiogram under the age of 6 years and such an audiogram did enable them better than anything else to meet the needs of Medical Officers of Health and others who demanded a clear-cut definition of the extent of the child's deafness.

Concerning finally the necessity for training technicians to assist otologists in these tests, Mr. Hallpike said that the technical procedure was designed to be fundamentally simple and capable of being understood and supervised by otologists everywhere. With that proviso it was not really necessary to create another branch of technical auxiliaries, because any intelligent assistant could do what was required.

THE SCOTTISH OTOLOGICAL AND LARYNGOLOGICAL SOCIETY

The FIFTY-THIRD MEETING of the Society was held on Saturday, 29th, November, 1947, in the Ear, Nose and Throat Department of the Royal Infirmary, Edinburgh

President—DR ALEXANDER STRANG

The Meeting opened with a very interesting Demonstration of The Peep-Show Technique for Pure Tone Audiometry in Young Children*

The Demonstration and Film by M R DIX and C S HALLPIKE
(*Otological Research Unit Medical Research Council, Queen Square, London, W C 1*)

THE PRESIDENT thanked Miss Dix and Mr Hallpike for the very interesting demonstration

DR COLLINS stated that many of these deaf children were of subnormal intelligence and enquired whether it was possible to use the Peep-Show test on these children

DR RITCHIE PATERSON said he would like to add his appreciation of the work of Mr Hallpike and Dr Dix Their names were associated in his mind with the mountain fastnesses of research laboratories but here was an accurate instrument for the field of clinical otology This machine which they had evolved would gather in a great deal of material which would otherwise be lost For himself he intended to set one up in the school clinic

DR LAND asked if there was any significance in the fact that the light and sound signals were interrupted He could appreciate that the flashing light would be more arresting, but he would like to ask Mr Hallpike whether he found that the interrupted test tone was similarly more readily picked up by the child than the continuance tone used in ordinary audiometry

DR HOWIE said he had watched Mr Hallpike testing children with this apparatus 6 weeks ago Mr Hallpike, dressed in an ordinary jacket, looked just like himself now, in fact he hardly looked like a doctor at all There were no instruments in view, and he sat and talked to the parents of the children The children played with toys and became interested in making things work It was interesting to see how children to whom you could never have gained access became co operative by this means He thought this demonstration was of great importance in connection with the question raised by Dr Gavin Young about the education of deaf children

MR HALLPIKE in reply to Dr Collins said they could not test children without normal intelligence

Further, in reply to Dr Land he said this was a much more arresting

* For a full description of the test procedure and equipment reference should be made to the authors article in the *British Medical Journal* November 8th 1947 p 719

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signal. They had tried a sound that was on the whole time, and a light that shone continuously, but had found that the children took no notice of these.

DR. G. D. McDOWALL.

Paper—*Surgery of Ménière's Disease*: Review of surgical treatment—present day methods of treatment—report on 20 cases treated by alcohol injection of labyrinth and post-operative physiotherapy.

It has been observed many times that the scientific interest in Medicine depends on its unsolved problems. In this respect otology maintains an absorbing interest and not the least of these problems is the condition known as Ménière's disease or Hydrops of the Labyrinth.

Dandy refers to it as one of the most common ailments referable to the cranial nerves and a disease doubtless as old as the human race. It is doubtful, however, if Martin Luther was a victim of the disease when he performed the incredible feat of throwing an ink-well at the devil attacking his ear. It is alleged, that Dean Swift suffered from the condition, and in more recent times many observations were made by Hughlings Jackson, who was himself a victim.

Although the pathological changes caused by the disease are confined to the labyrinth the mental and physical disturbance resulting from recurrent attacks may soon reduce even the most robust individual to a state of chronic invalidism. Much care and encouragement must be given to these patients during their prolonged courses of treatment and particularly important is the rehabilitation necessary after operation.

In this short paper it is not proposed to consider medical treatment although medical measures are of proved value and should, in the majority of cases be given extensive trial. The difficulty in assessing any particular form of treatment is the tendency to spontaneous remissions, sometimes of considerable duration, but it is variously estimated that twenty to twenty-five per cent. of patients fail to respond satisfactorily to any form of conservative therapy.

When medical treatment is ineffective in keeping the symptoms in check the question of destruction of function must be considered. In most cases operation is not advised until there is evidence that conservative treatment has failed, resulting in the incapacity of the patient to pursue his or her occupation, and where there is good hearing in one ear and evidence of progressive disease in the other.

Everyone is aware of the large number of surgical procedures described in the literature, the number of them denoting the limitations and experimental nature of most of them. These methods were classified by Ramadier in 1933 who divided them into conservative and radical groups.

The former group included decompression measures such as lumbar puncture, trephination of the cerebellar fossa and puncture of the endolymphatic duct, whilst radical measures comprised destructive trephination of the inner ear and section of the VIIIth nerve.

From 1861 when Ménière described the clinical picture of the disease until 1938 no significant advance had been made—in establishing the pathology of Ménière's disease. In the latter year Hallpike and Cairns reported their findings in two cases.

Since their report a further eighteen cases have been described in which

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the essential pathological feature was dilatation of the endolymphatic system. From the surgical point of view it would seem therefore that the logical point of attack is the labyrinth itself, and of the operative measures employed the Portman Operation for drainage of the saccus endolymphaticus is believed by many to be a rational approach to the problem. The results, however, obtained by Cawthorne in two cases and Altman in three cases have proved disappointing. Woodman, on the other hand reported eleven cases of which eight were completely cured of vertigo. Technical difficulties appear to have caused the operation to be abandoned.

The surgical procedure of total section of the VIIIth nerve attributed to Charcot (1874) and Ballance (1894) has been extensively developed in America where Dandy reported a large series of cases. More recently workers in this country and elsewhere have advocated partial section of the VIIIth nerve where there is reason to save hearing, section of the vestibular division only being done.

Although subtotal section of the nerve is regarded by some as the operation of choice where substantial hearing remains or where there is early involvement of the other inner ear, others consider the operation a difficult one, not without danger and in many cases it has given disappointing results since the preserved hearing is distorted by tinnitus and is of little value. Walsh and Adson reviewing their results following partial section reported that in those cases in which hearing was preserved vertigo was not abolished and when vertigo was abolished hearing was not preserved.

Other methods employed are those aimed at abolishing function in the labyrinth, varying from opening of the perilymphatic space and removal of a portion of the membranous labyrinth from the external semicircular canal to alcohol injection by different routes. The former method has been advocated by Cawthorne, the latter by Mollison through an opening in the external canal, by Wright and Peacock through the tympanic membrane and stapes footplate, by Berggren through the nasal coil of the cochlea.

Day, in America, has reported a small series of cases in which he has attempted to abolish function in the vestibular portion of the labyrinth without interfering with cochlear function. His method entails the application of a light coagulating current to a needle introduced within the external canal near the ampulla and passed forward into the vestibule. In all of his cases the procedure resulted in complete loss of vestibular response to caloric stimulation, but the results as to cochlear function varied. In two cases there was a total loss of hearing, in two cases hearing remained at the same level as before operation. Three cases showed a further loss of hearing in the lower tones following operation but in one case with a uniform pre operative loss of 70 decibels, the hearing after operation returned almost to normal and has remained so for four years.

Although this procedure is still in the experimental stage it would seem that it achieves its primary object of destroying vestibular function and with modifications might be developed to the extent of retention of cochlear function by sealing off the cochlea from the vestibule without loss of endolymph from the former.

During the past twelve years Alcohol injection of the labyrinth has been

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employed as a radical measure in Dr. Simson Hall's Department. Within the last four years, twenty-two patients whose ages range from 26 to 77 years, on whom conservative therapy had failed to control the disease were treated by this method. This total represents twenty-nine per cent. of cases diagnosed as Ménière's disease during the period under review, a figure slightly above that quoted by other workers, but accounted for by the number of cases, referred to the Department by Medical and Neuro-surgical departments, on whom conservative measures had already been tried without success.

The approach to the labyrinth in this series was *via* the post-auricular route, a partial simple mastoidectomy being performed, opening the antrum widely and removing the outer wall of the aditus as far as the short process of the incus, the latter being removed if necessary to gain access.

With a motor-driven burr and using an operating microscope the canal is opened close to the roof of the vestibule. The membranous canal is exposed and a syringe with a fine needle attached is passed forward into the vestibule. A few minims of endolymph are withdrawn. The needle is left in situ and a fresh syringe attached from which three minims of absolute alcohol are injected. The operation is completed by stitching up the wound with a small drain at the lower end. The drain is removed with the stitches at the first dressing on the fifth day. There were no complications in this series.

The immediate post-operative result has been the same as in other forms of labyrinth destruction. The degree of disturbance after operation depends largely on the amount of function present in the affected labyrinth before operation. Thus where there has been little response to caloric stimuli before operation the post-operative disturbance is minimal.

Of the twenty-two patients treated by this method it has been possible to review twenty of them and record the following results. The sudden acute attacks of vertigo have been relieved in all cases, but in 7 there is transient dizziness on rapid movement involving a change of direction or on bending movements. Tinnitus has been relieved in 8 cases, diminished in 4 and unrelieved in 6. It was absent before and after operation in 2 of the patients. None of the patients retained hearing in the operated ear but 16 have been able to resume their regular employment.

Post-operatively the object is to have these patients sitting up and performing special exercises at the earliest moment, preferably as soon as the acute phase of the labyrinth crisis has passed. The routine exercises advised by Dr. Cooksey where the patients learn the exercises prior to operation and commence treatment the day after operation recognize the importance of restoring balance, of training the eyes, muscle and joint sense to accommodate for permanent impairment of labyrinth function.

With the introduction of Sulphonamides and Penicillin the fear of post-operative infection has to a great extent been abolished thus stimulating interest in labyrinth surgery. In addition the more common employment of the operating microscope has made operations on the labyrinth a more accurate procedure.

In none of the recent large series of labyrinthectomies for Ménière's disease, which have been reported, has there been a death. This relatively minor

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surgical procedure seems likely to replace the major surgical procedure of intracranial section of the VIIIth nerve

The final method of treating this common disease whether medical or surgical has not yet been evolved but much can now be done to relieve the distress of an individual suffering from a vertiginous attack or living in fear of an impending one

DR A BROWNLIE SMITH

Ménière's Disease—Alcohol Injection of Labyrinth.

Miss S, age 85

First seen in May 1946 as she had been suffering from severe giddy attacks for many years

The condition had been diagnosed in 1939 as Ménière's disease

She was almost blind from cataract, and was quite unable to get out of bed as she felt she was continuously giddy and could not even sit comfortably in a chair. She was not quite stone deaf in the right ear and she had slight nystagmus

Patient was told that the only treatment which would be likely to help her was destruction of the right labyrinth, but that in view of her age one declined to advise this procedure. She told her doctor that life was not worth living in her present condition and she decided to have the operation done

22 5 46 *Operation* Cyclopropane Anaesthesia. Usual mastoid incision antrum well opened up incus removed and lateral canal identified opening made into labyrinth with chisel and fine curette. A minim of fluid sucked out of the labyrinth and absolute alcohol injected. Wound stitched

Patient made a good recovery and was discharged on 1 6 46. Her giddiness entirely disappeared although she found considerable difficulty in believing that her giddy attacks would not return

When last seen, on 6 10 47, she was very well, able to get about the house quite well and she said she could sit at the fire quite comfortably. She told me, however, that when she is trying to get out of her room by herself she often fails to find the door and she appears to have lost a great deal of her position sense

Ménière's Disease—Surgical Removal of Membranous Labyrinth

William S, age 66

Referred from the Medical Out-Patient Department as he had been having severe attacks of giddiness and was quite unable to follow his occupation. Attacks came on without warning and he went about in fear of a sudden attack of severe giddiness

On examination both drums were normal. He had a marked deafness and could hear a conversation voice with the left ear at only about one foot

X ray of petrous bones was negative

Cold Caloric test showed a reduced response on the left side

21 6 47 *Operation* Gas, oxygen and ether anaesthetic

Usual mastoid incision antrum well opened up incus removed lateral canal defined. Opening made into the lateral canal with fine chisel and membranous canal picked out with crocodile forceps. Fine dental curette

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inserted into the vestibule and wall of vestibule gently curetted. Penicillin powder placed in the cavity and the wound completely stitched.

Patient was in hospital for about a fortnight but he has had no further attacks of giddiness since the operation. He is stone deaf in the left ear.

Patient had no disturbance of visual accommodation after the operation, although this often occurs.

DR. SMITH said that, with regard to Case 10, he had told the patient's doctor that he did not think it was worth while doing anything, but the patient was completely incapacitated and when the matter was explained to her she said, after considering it carefully, that life was not worth living. She is now well, and, though almost blind with cataract, can sit at the fire quite comfortably. One point of interest is that if she sits in the parlour for a time she has great difficulty in finding her way out as she seems to lose her sense of direction and position in the room.

Case 11 was a shipwright at Leith Docks who went about in fear of an attack of giddiness. Following on the operation he had had no attack. In fact the day after the operation he was able to sit up in bed and read a paper which was rather unusual so soon after the operation.

DR. GIBSON said that he had a very personal interest in Ménière's Disease and had had some experience of its surgical treatment. His experience had been limited to destruction of the labyrinth by Mollison's method and a partial section of the VIIIth nerve by exposure of the nerve through the posterior fossa. In those cases treated by Mollison's method the operation had been completely successful, in that there was complete freedom from any other attacks of paroxysmal vertigo. The reaction to be expected after the operation depended to a great extent on the activity of the labyrinth before the operation was done. In advanced cases of the disease there was only transient evidence of labyrinthine disturbance. In the small series in question there had been no fatalities and no complications. His experience of partial section of the VIIIth nerve was limited to one case that had been in the hands of that prince of Neuro-surgeons, Professor Norman Dott. The fact that four years after the operation the patient had had no useful hearing in the operated ear, could not be taken as a criticism of the operative technique, but was, in the speaker's view, rather an indication of the violence of the disease and the rapidity with which all useful hearing could be lost. In this case also there had been no alteration in the tinnitus but the operation was successful in that the patient had not had any further attacks of paroxysmal vertigo. This raises the question of whether in a well marked case of unilateral Ménière's disease there is anything to be gained by the more extensive and severe operation of partial section of the nerve, as compared with Mollison's method of alcohol injection into the lateral canal. It was the speaker's opinion that, at the present time at any rate, partial section of the nerve should be limited to those unfortunate individuals who were threatened with, or who suffered from, bilateral disease.

DR. HALL said that to him the essential question in the treatment of Ménière's disease was how to preserve hearing while blotting out the labyrinthine function. Dr. McDowall had shown that partial section of the nerve is unsatisfactory. Undoubtedly this disease does in the end destroy hearing, but he had in mind two patients who had been under treatment for 10 years

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or more The vertigo was controlled up to a point with one form of treatment or another and they still had sufficient hearing in the affected ear to be of use should the hearing in the other ear be lost In our search for the answer various treatments have been tried including the coagulation of the superior and horizontal canals and blockage with various substances, but these experiments failed to provide a solution There may be further operative developments which will give more help It has been noted that tearing of the vestibule or canal during a fenestration may destroy vestibular response but provide improved hearing He had had a case in which this had occurred A colleague had told him of a case in which the labyrinth was completely sealed off where the horizontal canal enters the vestibule If we could save cochlear function we could give the patients 10 to 15 years of useful hearing

DR McDOWALL said in reply that in his experience of partial section of the nerve one patient had total loss of hearing 48 hours after operation and the second, who had a 25 decibel loss before operation, had shown a 70 decibel loss after operation The incidence of bilateral involvement is higher than was at one time suspected

DR G EWART MARTIN *Vicarious Menstruation*

M J, aet 18 Curious case of vicarious menstruation which has been recurring from year to year mainly in the summer time

Full notes of this case will be obtainable later The lining of the nose gives the picture of a capillary hæmatoma so that there is not bleeding from a single point as is usual in vicarious menstruation but from the complete side of the nose

Further reports, including gynæcological report, with the patient

DR MARTIN said this case was interesting in that the patient menstruated twice a year through the nose and the rest of the time normally Sections shown were very like allergic tissue in the nose His feeling was that the less that was done for this the better There was no perforation of the septum The patient was under treatment by a gynæcologist

Case and Slides for Diagnosis

M H, aet 16 Clinically it resembles a blastomycosis of the nose and larynx but the pathologists suggest the thickening of the mucous membrane may be allergic

Admitted to the ward for direct examination of the larynx and œsophagus had previously been examined by Dr Venters History of having had tonsils removed a year ago and since then has complained of difficulty in speaking and marked difficulty in breathing

On examination there was a mass of lymphoid tissue completely surrounding the trachea, extending over one inch

Pathological examination of this suggested simple granulation tissue

A similar thickening of the nasal mucosa, starting first on the right side and slightly on the left

This suggested a blastomycotic condition

Sections exhibited for comment

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DR. MARTIN said that a biopsy had been done previously on this case by Mr. Venters. The report had been ordinary granulation tissue but with a very marked number of lymphocytes as in an erythema nodosum. He thought a tracheotomy should be done in this case and the patient kept as quiet as possible. The larynx only admitted very little more than a knitting needle. Various sections had been sent to the pathologist who had sent these to different centres for examination but with no help.

DR. HENDERSON said he had seen two cases of blastomycosis but they had been very much more advanced than the case shown. The mass had occupied the whole of the nose and finally eroded through the frontal sinus bone and produced proptosis. He did not think this was perhaps much help as there seemed little resemblance between the two cases. This case was very much slower or appeared so from the history.

DR. COLLINS asked if the chest had been X-rayed and if examination of the sputum had been made. Many of these cases with granulomatous conditions in the nose and in the larynx had an underlying tuberculous condition.

In reply to Dr. Henderson, Dr. Martin said this was not a blastomycosis but it might be a chronic allergic type of swelling.

In further reply to Dr. Collins he said that the chest had been X-rayed and the patient had been seen by various physicians. The pathologists had suggested that apart from a chronic allergic condition it might be specific. As the patient's mother was in another ward in the Hospital the opportunity was taken of having a Wassermann and Kahn done on both patients but these were negative. There is no suggestion of tubercle. The mother who was in hospital on account of a condition of the knee was diagnosed as suffering from rheumatism.

C.O.M.S. Circumscribed Labyrinthitis.

J.T., aet. 16.

28.6.47. Admitted to the ward. History of having had trouble with the left ear for 2 or 3 years. Four weeks ago ear became painful and has discharged since then : continuous giddiness for past 4 days, with vomiting.

On examination the anterior part of the left drum markedly bulging. Spontaneous nystagmus—2nd degree : no fistula symptom : hearing a whisper at 5 inches.

Conservative treatment and penicillin.

14.7.47. Still continued with giddiness and vomiting.

Modified radical mastoid operation : very large fistula into the lateral semicircular canal. This was thoroughly cleaned and a flap placed loosely over it.

The recovery was uneventful ; cavity is now healed and healthy : hearing a whisper at 7 feet.

DR. GAVIN YOUNG said he would like to congratulate Dr. Martin on his conservative treatment of this case. He thought the case had shown a very good dividend in the tremendous preservation of hearing. From the notes it appeared a large fistula was found on operation. He would like to ask Dr. Martin if there was any cholesteatoma present.

DR. MARTIN replied that there was no cholesteatoma.

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MR HALLPIKE asked in which direction was the nystagmus

DR MARTIN said he could not answer that as he had just taken over the case prior to operation. There was no fistula sign, yet when they had operated they had found this large fistula. He had gone on rather boldly and covered this and there was certainly no fistula sign now.

He was entirely against destruction of function if this could be avoided. It was the custom in their Department, the day after a radical mastoid operation, to test the patient's hearing with a Barány box in the opposite ear. If there was no hearing in the operated ear then a second operation was carried out. His teaching was never to destroy function as one never knew what might happen to the other ear. In this case they had tried to preserve the hearing.

COMS *Extradural Abscess*

DF, aet 31

Had pain in the ear followed by discharge from the ear in May, 1947 admitted to the Medical Ward with a paralysis of the left arm and left leg seen by Mr Dott who thought he had a thrombophlebitis secondary to the ear condition on the right side.

Kept in the ward for a time and then sent to the Astley Ainslie for Electrical Treatment. Improved but started with pain in the ear and was re-admitted to the Medical Ward and sent across to us for examination of the ear.

There was an attic perforation of the right drum, with granulations.

A modified radical mastoid operation was performed. There was a destruction of the whole of the tegmen and a large extradural abscess with about 1 ounce of pus.

The ear healed perfectly.

After the operation it was noticed that this patient had rather a curious voice which, on questioning, he dates to the same time as he was admitted to the Medical Ward.

On examination it was found he had a fixation of the left cord.

The ear is healed, the general condition has improved apart from the voice, but that has also improved slightly.

It is difficult to correlate the paralysis with the ear.

This case was shown for diagnostic interest. He did not think the leg had anything to do with the ear condition. He had seen this case late. There was a history of paralysis of the left leg and left arm and it was only after two months treatment in the Astley Ainslie and the patient complained of a husky voice that it was discovered that there was a paralysis of the left cord. From the surgical side the diagnosis was a thrombophlebitis. He could not see how there could be a connection between the left leg, left arm and the cord.

DR YOUNG wondered if there was not a degree of torsion of the larynx. It appeared to him to have been rotated slightly.

DR MARTIN replied that the patient's history as given by himself was that the voice went the day before the arm and the arm went before the leg.

COMS *Cerebellar Abscess Osteomyelitis*

DC aet 46

Patient, who has had a slow growing osteomyelitis of the whole of the mastoid process following the use of penicillin in a radical mastoid.

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Radical mastoid operation in *July, 1947* : had a slight facial weakness after the operation along with a complete absence of hearing. There was a fine nystagmus.

Given large doses of penicillin.

Lumbar puncture was white, opaque and cloudy : no organisms found.

Penicillin continued along with sulphonamide.

Patient continued to run a temperature. Cell count fell from 620 to 200 and remained at that for some time.

Penicillin stopped and ear settled down apart from headaches. Cells reduced to 3. Headaches continued especially over the back of the head and the side of the head.

Re-admitted to hospital on 18.9.47 and the ear re-opened. It was found that the whole of the petrous temporal was a sequestrum with a very large cerebellar abscess from which no culture could be obtained. The facial had to be dissected out of the sequestrum, left in position, decompressed and is evidently recovering.

DR. COLLINS said he had seen a similar case about a year ago. He had noticed in the notes about Dr. Martin's case that sequestration of the inner ear followed the use of Penicillin in a radical mastoid operation. Whether this was by accident or intent he was not quite sure but in his case the patient had undergone a radical mastoid in the South of England following meningitis and although Sulphonamides had been given the patient had received no Penicillin. When the patient came North the radical mastoid was still discharging profusely and a facial paralysis was present. The notes obtained from the Hospital down south stated that a sequestrum had come away from the inner ear. Radical mastoid operation had to be revised on account of the filthy discharge and granulations and at this revision the whole of the inner ear was found to be a complete sequestrum. The two ends of the facial nerve were identified with a very small stump coming from the facial canal. Though these were freed it was difficult to get any real bed for the two ends of the nerve to rest on and a muscle graft was inserted but it did not prove successful.

In these cases of osteomyelitis of the inner ear he personally thought that the type of organism played a great part and that many of them were caused by anærobic streptococci. It was, of course, natural that when Penicillin had been given nothing should be found on culture.

DR. HOWIE said that in these cases of brain abscess and otogenic meningitis he thought they would have to review their position with regard to the use of penicillin. A comparison between the pre-penicillin and sulphonamide days and now would make an interesting subject for discussion.

DR. MARTIN said this was a case in which he thought his own teaching was at fault. This patient had developed a marked labyrinthitis but they had not re-opened the ear. Instead the case was treated with penicillin over a long period and you had a practically sterile ear. Following on the labyrinthitis the patient developed a meningitis, after having had penicillin and sulphonamide. The cell count came down to 200 and remained at that figure until the penicillin was stopped when it came down to 3 or 4.

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DR I SIMSON HALL

Plasmacytoma of Subglottis

Stanley F, aet 35 Seen 18 6 47

Complaint breathlessness

Previous history Gave a history of having had an operation in the R A F in March, 1945 when a mass was removed from subglottic region Diagnosis Plasmacytoma

Recurrence in June, 1945 and received a dose of 5000 r by teleradium This caused improvement but a further positive specimen was removed in September, 1945

Present Illness 23 6 47 Tracheotomy required to relieve severe obstruction

5 7 47 Direct examination Biopsy report—Plasmacytoma

X ray examination of skeleton—negative No proteinuria Blood examination normal Wassermann reaction—negative Kahn Test—negative

Treatment X-ray therapy by small doses over a prolonged period

Present Condition Slides shown

DR HALL said this case was of pathological interest He was indebted to Air Commodore Dickson for the early treatment of this case The tracheotomy excludes any danger of choking Why in the first instance radiotherapy failed and in the second instance was successful he was not prepared to say Recurrence was a very common experience in such cases and this one would have to be watched for a considerable period before they would know if this was a cure

AIR COMMODORE DICKSON said he had seen this case in 1945 There was then a small subglottic tumour growing on the right side of the larynx He had removed a piece for biopsy which had been reported as plasmacytoma The patient had been referred to the radiologist and he received a tumour dose of 5000r by teleradium The growth disappeared for about six months, when the patient again complained of the same symptoms and on examination a recurrence was noted Further tissue was removed and the report was again plasmacytoma

Stenosis of Subglottis

Audrey H aet 12

Seen first 10 9 47

History Had tracheotomy at 1 year old Tracheotomy scar has discharged at intervals since chiefly when child has a cold Developed increasing obstruction which at times became alarming

Examination 12 9 47 Thick scar tissue seen in anterior part of larynx small posterior opening

16 9 47 Posterior opening dilated

25 10 47 Dilatation not sufficient and endotracheal division of scar tissue carried out with subsequent dilatation of subglottic region

The dilatation treatment is being carried out regularly and appears to be improving the condition

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DR. ROBERT B. LUMSDEN.

Osteomyelitis of Frontal Bone.

David I., aged 70.

9.6.47. Discharge from centre of forehead for $2\frac{1}{2}$ months: no pain: no nasal symptoms.

Examination. Frontal swelling, size of half-crown, in mid-line, with several discharging sinuses: A.R. septum acutely to left: crusting of right middle turbinate: P.R. normal: C.N.S. nil.

Pus, from skin sinus: pneumococcus, type 31 ++, H. Influenzae+++ on culture. Blood Wassermann negative.

X-rays (films on view): "L. antrum opaque: Frontal sinuses partially opaque: Walls are blurred, indicating infection of the frontal bone itself."

Three-hourly I.M. penicillin commenced 24 hours before operation (total 1,000,000 units).

17.6.47. *Bilateral frontal sinus obliteration*, through anterior cross-bow incision. Fistula in anterior bony walls of both frontal sinuses, high up medially. R. frontal sinus contained foul pus under pressure, and posterior bony wall absent, exposing area of dura, size of half-crown. Bony inter-sinus septum largely destroyed. Medial half of L. sinus contained unhealthy granulations. Bony disease extended upwards beyond the upper medial extremities of both frontal sinuses, for about one inch. Bone removal carried well beyond the unhealthy margin. Ethmoids exenterated and L. antrum drained. Cavity washed out and dusted with penamide powder. Tube drainage through both sides of nose, and lateral extremities of wound.

Pus. Aerobic culture—pneumococci.

Anaerobic culture—no growth.

Bone. No growth.

C.S.F. Cells—1 per c.mm. No organisms.

Culture—no growth.

Total protein—30 mgms. %.

Wassermann—negative.

Colloidal gold—oooooooooooo.

1.7.47. Discharged to Convalescent Home.

11.7.47. *X-ray*—No sequestration. B.S.R. 10 mm./hr. Discharged.

30.7.47. *X-ray*—unchanged.

DR. LUMSDEN said this was a chronic osteomyelitis with an entire absence of symptoms apart from the discharge for $2\frac{1}{2}$ months. The other interesting point was the bacteriological findings—a culture of pneumococcus being obtained.

DR. HOWIE said he would like to congratulate Dr. Lumsden on the result of the operation. He would like to know if Dr. Lumsden had any experience of incision through the scalp behind the hair line. He had treated about 10 patients by this method and found that the aponeurosis of the scalp preserves some of the contour in the supra-orbital region, and allows of bony reformation in the area where bone has been excised.

In reply Dr. Lumsden said he had treated one case of acute frontal osteomyelitis by this method, along with penicillin, with success. In this particular case it was a chronic lesion and, apart from the fact the patient was

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bald, it would have been a more severe operation at his age, so the more conservative line of treatment had been chosen

DR I MALCOLM FARQUHARSON

Keratosiis of the Larynx

W W, aet 38

History of laryngitis for 15 months no pain on swallowing takes colds frequently

Occupation Engineer

Habits Heavy smoker, now stopped

9 11 46 On examination by indirect laryngoscopy, both vocal cords are very congested and granular in appearance there was a white membrane lying over the right cord, at the middle third of the right cord there was a curious villous projection on the edge of that cord

X-ray of chest showed pleural thickening at the right costophrenic angle probably the residue of an old pleurisy no evidence of T B

X-ray of paranasal sinuses showed no evidence of any infection

Wassermann reaction was negative

Diagnosis of Keratosiis of Larynx was made

Treatment Voice rest as far as possible without stopping his work Vitamin therapy with Vitamin A concentrates spraying the larynx with 1 per cent ichthyol in water

This treatment was carried out for four months with some improvement in the voice but no improvement in the local condition

23 3 47 *Examination by direct laryngoscopy*, leukoplakia of the left cord with a similar condition on the right cord on the right cord there was a white elevation on the edge of the middle third of the cord—this projection was suspicious of a neoplasm This material was stripped off the cord completely, leaving quite a healthy edge to the cord The material was sent for pathological examination

Biopsy The submucous tissues are irregular and in one region heavily infiltrated with round cells The mucous membrane itself is slightly hyperplastic in one region and through the specimen is covered by an excess of hyaline material resembling keratin No malignancy, however, is discoverable

The condition is a keratosiis of the larynx

Microscopic section on view

DR FARQUHARSON said that he had shown this case in order to promote discussion on two points Firstly, whether this condition was always a pre-cancerous one, opinions differed on this point, Jackson thought it was not pre cancerous while others thought otherwise secondly whether by histological examination of the tissue it was possible to predict in which cases a pre cancerous condition might occur

DR T J REID (introduced by Dr I Simson Hall)

Atrophic Rhinitis in Twins

Elizabeth and Jean B, twin sisters aged 12

7 4 47 Both girls reported as out patients, complaining of thick nasal discharge, feeling of dryness in the nose, difficulty in breathing through the

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nose and a bad smell. Their mother said that the condition lasted for 18 months. The reason for reporting now was that the girls complained of increasing bad smell, of which the mother was only aware recently. No relevant family history. Both girls look exactly alike.

Previous History. Both girls had measles and whooping cough at the age of 2. In *October, 1940*, Jean had scarlet fever, Elizabeth was very ill but scarlet fever was not diagnosed.

On Examination a marked broadening of the base of the nose was noticed in both girls. A.R. revealed large nasal cavities, with atrophic type of mucosa, full of dry purulent crusts in the olfactory clefts. Fœtor was not noticed. The cavities were not of equal width—one of the girls had the right side wider, the other the left side. P.R. nil abnormal. The pharynx looked healthy.

X-ray of Sinuses revealed identical slight opacity of all sinuses.

W.R. and Kahn Tests—negative.

Biopsy of nasal mucosa. The condition is chronic atrophic rhinitis.

Since first seen, the twins have been treated with alkaline nasal wash-outs followed by instillation of $1\frac{1}{2}$ cc. ($2\frac{1}{2}$ mgm.) of Stilboestrol in form of a nasal spray, three times a week and wash-outs at home in between. In two weeks' time there was already a marked improvement, the subjective fœtor disappeared and the crusting was less.

The condition kept on improving and the nasal mucosas regained nearly their normal appearances, up to three weeks ago. Since, the twins started to complain again of fœtor, and, on examination, the noses were once more full of crusts. It was suggested that Stilboestrol might have lost its power because of the prolonged use (7 months) and therefore it was discontinued and the twins are having for the moment only the nasal wash-outs. It is proposed to resume the Stilboestrol treatment after an interval of one month.

DR. HENDERSON asked if anyone had had any experience of recent work being done in one of the Scandinavian countries on this subject. He understood that they were treating the patients with extract from the tonsils. The tonsils are always small in cases of atrophic rhinitis and atrophic rhinitis often follows their removal. Cases are treated with tonsil extract. He understood that good results had been claimed for this treatment but he had had no personal experience.

DR. HOWIE said he thought the gentleman came from Budapest.

EXHIBITS.

DR. A. BROWNLIE SMITH.

X-ray Plates. Extreme cellularity of mastoid process.

Helen D., aged 17.

Complaining of pain and swelling behind left ear for some months. Nothing really wrong in ear but X-ray shows extremely cellular mastoid processes.

Margaret J., aged 17.

Complaining of pain and swelling behind the right ear. Nothing seen wrong in the ear but X-ray shows extremely cellular mastoid processes.

X-rays of those two cases shown as there have been quite a number of

The Scottish Otological and Laryngological Society

patients, all in adolescent age, complaining of some discomfort or swelling over the mastoid process and the only abnormality detected has been excessive pneumatization. It would appear that the continued development of the mastoid cells was sufficient to draw the patient's attention to this simple physiological process.

DR SMITH said he had shown these X-rays as a point of interest. He remembered before the war having quite a number of young people between the ages of 14 and 17 complaining of pain over the mastoid process. He could never discover any abnormality in the ear. He had had a number of cases X-rayed and the X-rays showed extremely cellular mastoid processes. Whether there was anything in this he did not know, but there was no doubt that quite a number of adolescents complained of growing pains over the mastoid process. It might be a matter of personal appearance, the young man drawing his young girl's attention to a swelling behind the ear and continual rubbing producing the pain, or, as the X-rays showed, extensive pneumatization of cells. There is a little loss of translucency over the edges of these cells which are still in the process of development. It may be that this actual process of pneumatization is sufficient to draw the attention to the fact that there is a mastoid process.

None of these cases had had any swelling of the mastoid gland and there was no scalp infection which would cause any swelling of the gland.

In reply to a question that the pain might be caused by an impacted wisdom tooth, Dr Smith replied that he had seen cases with cellular mastoid processes between the ages of 14 and 17 years and an impacted wisdom tooth did not occur at the age of 14 or 15.

DR ROBERT B LUMSDEN

Microscopic section tissue from inferior turbinate showing infection with *Rhinosporidium Seebertii*.

Tissue from inferior turbinate showing gross infection with *Rhinosporidium Seebertii*, the sporangia being present in all stages of development.

Clinical data Indian Sepoy, aged 21.

Complained of right sided nasal obstruction and of intermittent epistaxis for three years.

Localized granular fleshy mass involving middle portion of R inferior turbinate bleeds readily.

DR I MALCOLM FARQUHARSON

Microscopic section

Diagnosis Basosquamous carcinoma of the exterior auditory meatus

I B, aet 63

History of slight deafness with bleeding from right ear for some months

5 4 47 Examination showed large sloughing polypus growing from right external meatus appeared to be attached to posterior bony meatal wall

16 4 47 Operation—polypus removed with snare and forceps, it was adhering to posterior meatal wall

Histological Report Tumour has topography of a rodent ulcer, but shows distinct stratification at many points and considerable mitotic activity. It

Societies' Proceedings

is locally degenerated and complicated by marked irregular infiltration with inflammatory cells. The condition is a basisquamous carcinoma.

24.5.47. Radium tube introduced into external meatus for 8 hours.

7.8.47. Evidence of recurrence confirmed by biopsy.

2.9.47. Patient put on to deep X-ray therapy.

DR. FARQUHARSON said he had exhibited this slide because of the unusual site of this type of growth and the fact that recurrence had occurred some distance from the original site suggesting a subepithelial spread.

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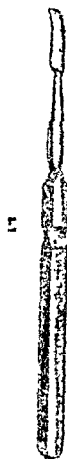
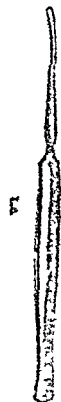
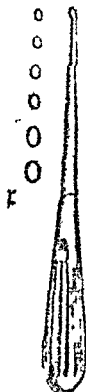
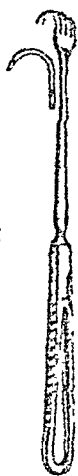
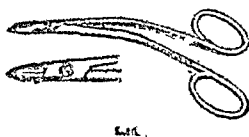
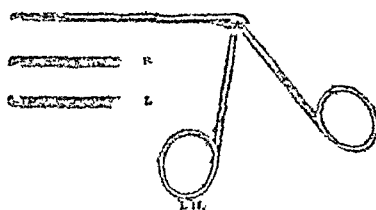
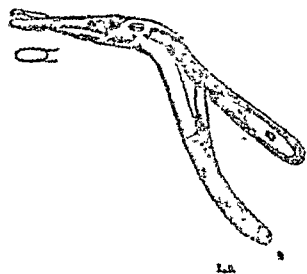
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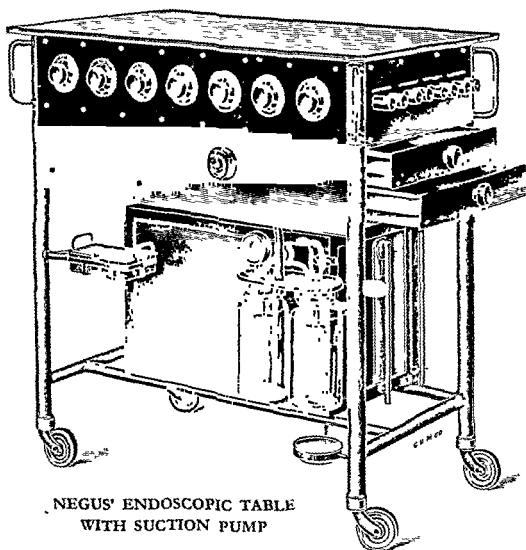
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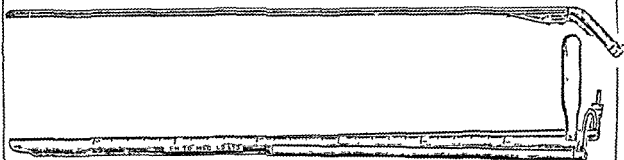
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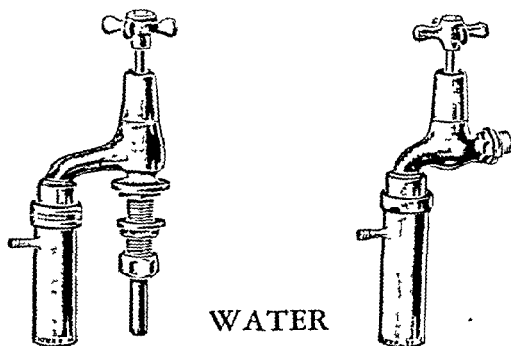
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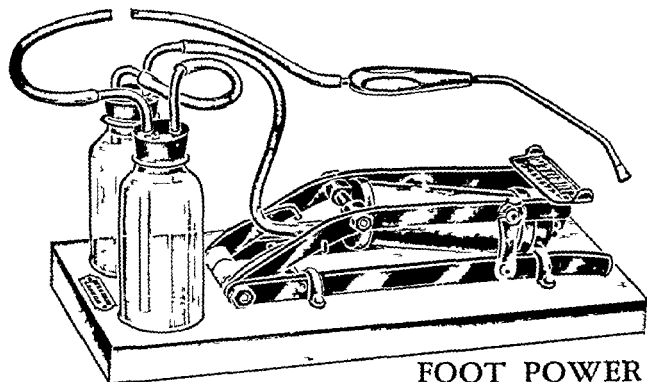
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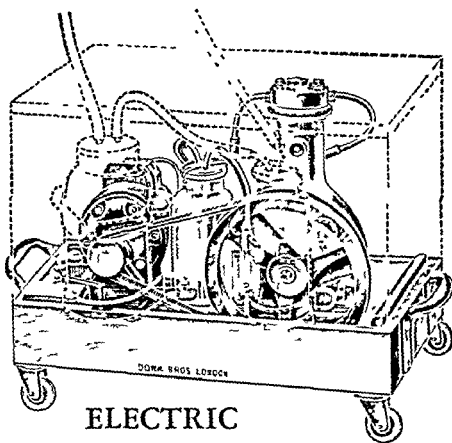
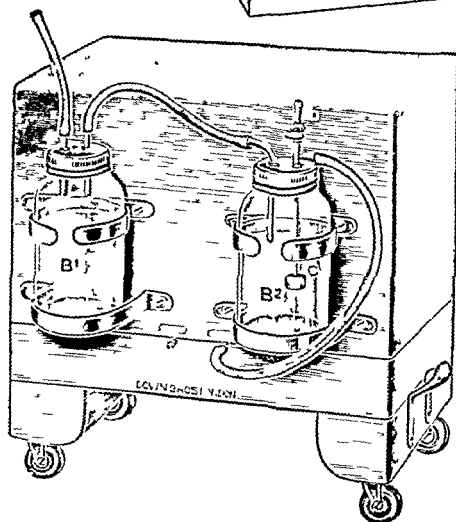
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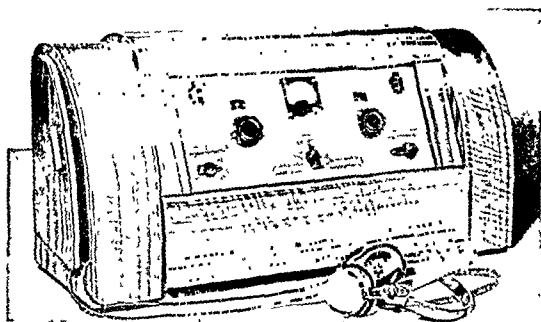
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July 1948

SURGERY OF AURAL SUPPURATION AFTER RADICAL MASTOIDECTOMY

By J A HARPMAN (Warwick)

FOLLOWING complete or epitympanic radical mastoidectomy, purulent otorrhœa sometimes continues notwithstanding much post-operative conservative treatment. The pathological processes causing such suppuration are commonly located about the eustachian tube opening into the middle ear, or in the hypotympanum, the antero-superior part of the attic, the incus or malleus, the petrous bone about the semicircular canals, or rarely the petrous apex. In this note there are detailed antauricular and transmeatal or endaural procedures that I have found, in some fifteen cases, to allow of more satisfactory eradication of such sites of suppuration than postaural re-doing of the tympano-mastoidectomy. The operations in question entail essentially the preliminary steps employed in surgery upon the petrous apex by Lempert (1937), Langenbeck (1937), Ramadier (1933), Ramadier Guillon and Becker (1932), Almour (1938) and others.

Visualization of and approach to the inferior and anterior regions of the tympanic cavity is sometimes obstructed by the upward and backward convexity of the tympanic bone, especially when previous mastoid surgery has led to some downward and forward sagging of the auricle. When, in such a case, there are foci of suppuration in the hypotympanum, in the eustachian tube or in cells about its tympanic ostium, approach to these is greatly facilitated by removal of anterior and inferior parts of the tympanic bone. This is accomplished as follows. An incision down to bone is made transmeatally along the anterior and inferior aspects of the tympanic bone about 1 mm. medial to its junction with the fibro-cartilaginous external auditory meatus, a suitable scalpel for this is a size

J. A. Harpman

15 Bard Parker blade mounted on the usual handle. The skin and periosteum on the meatal surface of the anterior and inferior aspects of the tympanic plate are elevated and removed. With a small periosteal elevator the external auditory meatal fibro-cartilage is separated from the tympanic bone, and the periosteum over the anterior and inferior regions of the bone is then elevated. Confining instrumentation to below the glaserian fissure and away from the posterior part of the tympanic bone prevents entering the temporo-mandibular joint and injuring the facial nerve. Use of a flat retractor between the tympanic bone and its anterior and antero-inferior periosteum accords further working space. The anterior and antero-inferior parts of the tympanic bone are then removed with rongeurs, almost or quite until reaching the annulus tympanicus. The portions of tympanic bone to be removed are sometimes so thick that it is advisable to thin them first with gouges or burrs. The inferior and postero-inferior parts of the tympanic bone may also be thinned with gouges or burrs to provide better exposure of the middle ear. In some cases it is advisable to remove the inferior part of the annulus tympanicus with a rongeur such as that of Kerrison, or with a dental burr. These procedures allow excellent visualization of the inferior and anterior parts of the middle ear.

There may now be found granulations and infected cells in the hypotympanum, often extending several millimetres medial to the promontory, especially between the bony eminences covering the jugular bulb and internal carotid artery. I have not yet found such sub-cochlear cells extending into the petrous apex. There may also be cells and granulations on the carotid canal and about the tympanic ostium of the eustachian tube; granulations may be seen covering the promontory. These cells can now all be thoroughly exenterated and the granulations and the diseased lining of the eustachian tube removed by using curettes.

West and Scott (1909) advised removal of the anterior part of the tympanic bone to improve access to the anterior part of the tympanic cavity, especially in operations on the cochlea. In their operations for anterior and apical petrositis, Ramadier (1933), Ramadier, Guillon and Becker (1932), Almour (1938), Langenbeck (1937), and Lempert (1937) treat the tympanic bone as described here, except that Almour (1931, 1932, 1938; Kopetzky and Almour, 1931) usually only thins it.

Smith (1931) advises that in radical mastoidectomy anterior and inferior portions of the tympanic bone be removed sometimes to provide better access. Portmann (1921) advises partial or total removal of the anterior part of the tympanic bone and thinning its inferior part to improve access for removing bullets embedded in the petrous bone. Piffi (1903) removed most of the tympanic bone in his approach to the jugular bulb.

Surgery of Aural Suppuration

Ramadier (1933), Langenbeck (1937) and Barth (1936-7) found that in some of their patients removal of the anterior part of the tympanic bone caused temporary dental malocclusion, trismus or pain on chewing, but patients did not suffer from these complaints with the exception of two who had moderate pain along the angle of the mandible and in front of the ear, especially on opening the mouth wide or on chewing solids, during the first few days following the operation

The postero-superior wall of the upper ascending part of the carotid canal is thin and here the canal is easily entered. Accidental hæmorrhage from the internal carotid artery where it courses through its bony canal can apparently be satisfactorily controlled by packing with gauze (Tato, quoted by Beyer, 1945, Richards, 1927, Ramadier, Leroux and Bousquet, 1933, and others). Dehiscences of the bone between the jugular bulb and hypotympanum may occur (e.g. Beyer, 1945, West and Scott, 1909, Lillie, 1938, Larsell, 1946, Brunner, 1946, Kerrison, 1930, Toynbee, quoted by Ballance, 1919, etc.). Brunner (1946) also remarks that a jugular bulb that does not bulge markedly into the tympanic cavity is usually separated from it by thick bone. In one of my cases curettage of the hypotympanum produced a hæmorrhage from the jugular bulb, it was controlled by packing the middle ear with gauze for about seven minutes, after which the operation was continued. In this patient the bone over the shallow jugular bulb dome was very thin and may have been dehiscent, the tympanic bone was also unusually thin.

Foci of suppuration in the upper parts of the middle ear and in the mastoid part of radical mastoidectomy cavities may be reached by the following procedure. A curved incision about 2 cm long is made from the antero-superior angle of the external auditory meatus upwards along and just in front of the anterior part of the helix, taking care not to cut its spine, from which the anterior auricular muscle is detached. The incision may be made only as deeply as the temporal muscle, or, in difficult cases where wider access is required, down to bone. Several of the vessels divided may be found to require controlling by ligation or diathermy coagulation. The landmarks for the incision are obscured by preliminary regional infiltration with adrenaline solution, but if it be desired to do this the line for it may first be marked with a dye. The periosteum over the lower part of the temporal squama above the middle ear and mastoid process is elevated upwards and backwards until adequate exposure is obtained and maintained by holding the incision wide open with retractors. If dura mater has been exposed at a previous operation, great care is required to avoid injuring it should it be necessary to separate it from squamous epithelium lining the radical mastoidectomy cavity, it is then often safer to divide the skin around such an area of adhesion and not to interfere with the latter. Exenteration of diseased areas in the bone is carried out as usual with curettes, gouges or burrs.

J. A. Harpman

By this approach I have been able in one case to re-do a radical mastoidectomy, perform a combined Hinsberg and Neumann labyrinthotomy, expose the endolymphatic sac, exenterate a posterior petrositis exposing the dura mater of Trautmann's triangle to within about 0.5 cm. of the porus acusticus internus and expose considerable areas of middle fossa dura mater and lateral and superior petrosal sinuses, with no more, and, I believe, actually less difficulty than would have been encountered using the postaural route. Surgery of the mastoid tip is also quite feasible through the antauricular endaural approach, although not as easy as by the postaural route.

The two methods here described are also suitable for converting epitympanic into complete radical mastoidectomies; which of them then to use depends upon the anatomy and pathology of the particular case, and upon the extent of the surgery it is desired to perform.

The procedures described are difficult to carry out unless during the operation blood is removed by suction and hæmostasis obtained by using from time to time gauze or cotton wool tampons moistened with adrenaline solution. The carotico-tympanic branch of the internal carotid artery especially may bleed fairly briskly for a few minutes.

I usually conclude the operation by packing the mastoid and middle-ear cavity with ribbon gauze impregnated with bipp, a method I have hitherto found superior to others.

Post-operatively, I generally remove the packing after about seven days; thereafter the operation cavity is kept clean by mopping with sterile cotton wool—wool-tipped probes being flamed prior to introduction into the ear—and usually instillation of drops of a solution of wide bactericidal and bacteriostatic range containing penicillin 1,000 units per c.c., flavazole 1 in 2,500, phenoxetol 2 per cent. and urea 10 per cent. in distilled water (P.F.P.U. solution). The use of urea in otology and in the treatment of infected wounds generally has been discussed by Kopetzky (1945), Williams (1946), and others (*B.M.J.*, 1947, 1948). Occasionally this solution causes dermatitis, sometimes with pyoderma due to non-penicillin sensitive staphylococci; this dermatitis responds to benadryl orally, and sulphathiazole or zinc oxide cream or gentian violet solutions applied locally; in such cases, the penicillin may be omitted from the solution, or solutions of soluthiazole or sulphathiazole 5 per cent. and urea 10 per cent. in glycerine or spirit 60 per cent., with or without proflavine, etc., may be used instead of the P.F.P.U. solution. Excessive granulation formation in the cavity generally yields successfully to applications of 10 per cent. silver nitrate solution, sometimes aided by mechanical removal; mercurochrome 2 to 15 per cent. in water or spirit is a useful alternative milder astringent.

The P.F.P.U. solution described above may also be found useful for preoperative preparation of the ear.

Surgery of Aural Suppuration

The methods described I have employed in fifteen cases Post-operative pain or discomfort has been almost non-existent

In three—children suffering from severe purulent chronic sinusitis notwithstanding Caldwell-Luc operations and much other treatment—some purulent aural discharge wells up from the eustachian tube fairly frequently. All the operation cavities are otherwise dry and entirely lined with squamous epithelium

For cases of continuing eustachian tube suppuration not responding to measures such as those indicated above, I have been trying a modification of Wittmaack's method (described by Beyer, 1945) of filling the tube, using a strip of temporal muscle instead of skin

SUMMARY

In this note there are described endaural and antauricular surgical techniques found more satisfactory than the postaural approach for dealing with aural suppuration following radical or epitympanic radical mastoidectomy and not responding to conservative treatment

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A NEW METHOD OF TRANSVERSE PHARYNGOTOMY

By A. RÉTHI* (Budapest)

TRANSVERSE pharyngotomy is an important approach for opening the pharyngeal cavity. Its importance consists in that the mesopharynx is exposed while, on the other hand, the posterior part of the tongue, the tonsillar region and the nasal part of the pharynx can easily be approximated by this approach. Further, transverse pharyngotomy does, if it has been done correctly, open the way to the laryngeal aditus, the arytenoideal region and epiglottis. Pharyngotomy may be necessary for various tumours, as well as for impacted foreign bodies and cicatrizing processes whereas epiglottic cancer is a less frequent indication. Tumours seated on the top of the epiglottis can readily be removed by direct approach but cancer infiltrations extending beyond the aditus, especially those on the laryngeal surface, exclude every intervention excepting radical extirpation. In the cases, however, in which the tumour has grown beyond the extension soluble by means of a directoscope but it has not reached the border of the aditus the success of a conservative operation may be hoped for. Finally, transverse pharyngotomy gives an excellent approach for the treatment of anomalies of the tongue base especially aberrant thyroid.

Two technical varieties of transverse pharyngotomy are known depending on whether incision is made above or below the hyoid bone. Pharyngotomia subhyoidea has been suggested for exposing the aditus and the surrounding pharyngeal region whereas pharyngotomia suprahyoidea is more recommended for an exposure of the tongue base and the superjacent parts such as the nasopharynx.

In the course of a subhyoid pharyngotomy (Malgaigne, Langenbeck) the incision is made from the one cornu of the hyoid bone to the other, the platysma is severed, then the sternohyoid, omohyoid, and thyrohyoid muscles are dissected off the inferior surface of the hyoid bone. The liberated hyothyroid ligament is cut close below the bone lest the superior laryngeal nerve be injured. After this has been done the pharyngeal cavity will be opened by severing the mucosa. Hereby insight is obtained mainly downward to the aditus and the pharyngeal cavity. Upward insight is prevented by the body of the hyoid bone. Kahler has called attention to another disadvantage of this operation, i.e. to the downward

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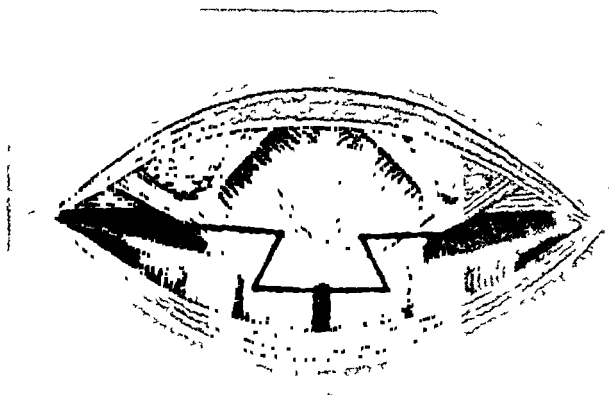


FIG. 1

Anatomic situation after the skin incision. The black line running over the muscles and the hyoid bone corresponds with the incision.

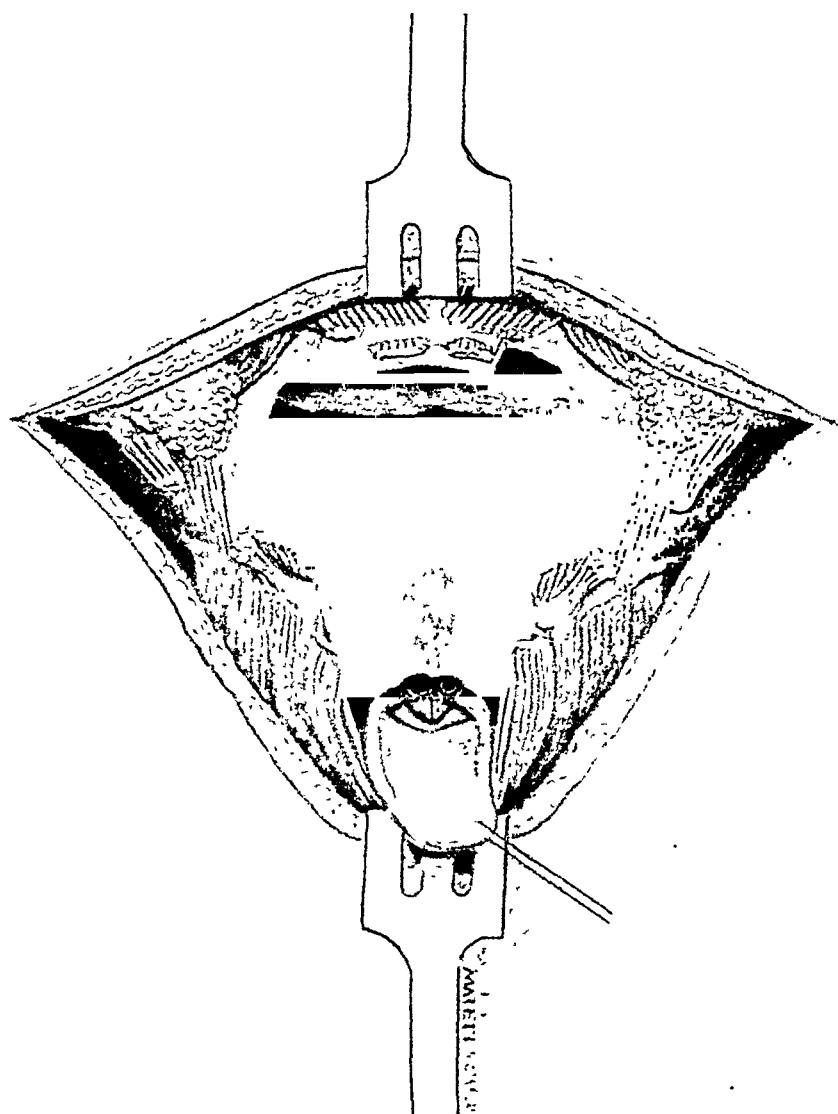


FIG. 2

Having severed the muscles, the hyoid, and the pharyngeal mucosa, free insight is allowed both upward and downward

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pulling of the larynx due to inspiratory strain and cough whereby sutures readily cut through. He observed in several cases opening of the wound for this reason. Similar cases occurred also with my patients.

For suprahoid pharyngotomy (Jeremitsch, Hacker), the incision is made above the hyoid bone. For this reason the mylohyoid and geniohyoid muscle and the medial part of the hyoglossus must be severed. An excellent insight to the tongue radix, the upper part of the pharynx, and the nasopharynx, may be obtained especially by bisection of the palatum to expose the cranial basis as has been suggested by Hoffman. Both palatal arcs and the tonsils are likewise exposed through this operation having the great disadvantage that the severed tongue muscles will, despite the most careful uniting, pull the sutures on deglutition until they become loose. Owing to this, sinking of the larynx may ensue with the impending danger of an aspiration pneumonia.

Since the disadvantages of both technics frequently became apparent in my practice I aimed at a procedure which united the advantages of both, that is the free insight upward and downward, excluding aspiration even in the cases of abundant bleeding, and securing an uneventful healing of the wound.

Prior to pharyngotomy I always perform an inferior tracheotomy. It is of little importance as an additional strain whereas its existence may be of great advantage during the days prior to and following operation. Tracheotomy is for instance indispensable in preventing intra operative blood aspiration or the occasional post operative oedema of the larynx.

A round bolster is put under the shoulders of the patient in order to secure a deep backward flexion of the head. Usually local anaesthesia is sufficient. The area of the operation forming a square rhombus, with one end at the anterior border of the sternocleidomastoid at the level of the hyoid bone, is infiltrated with a 0.5 to 1.0 per cent novocain solution. The incision is started at the one end of the hyoid and extends to its other end, thus having a length of 10 to 12 cm. Platysma is severed. Now the hyoid bone covered by muscles is exposed. These muscles must not be injured. The submandibular gland and the hypoglossal nerve are pushed upward 1 cm. below the hyoid margin, along the whole length of the bone, the omohyoid, sternohyoid and thyrohyoid are severed. Care is to be taken that these muscles should be cut at a length corresponding with the hyoid bone. The hyothyroid ligament is cut in the same width. After penetrating the fat tissue the transparent epiglottis appears. The pharyngeal mucosa should not yet be opened. Thereafter the hyoglossus and the constrictor muscle adhering to the greater cornu are cut on both sides at a distance of $3/4$ cm. above the cornu whereas the tendon of the digastric and the stylohyoid should not be cut but only liberated from the periosteum. Thus the pharyngeal mucosa has been reached but still the pharynx should not be opened. Now the most

important section of the procedure follows, that is the temporary resection of the hyoid bone. For this purpose a vertical incision measuring about 0.5 cm. is made on both sides of the hyoid near the conjunction of the body and the great cornu through the muscle bundle and the bone is severed by a pedicled saw used in delicate rhinologic operations. At this moment one of the assistants should, by means of a hook retractor, retain the hyoid in its place lest it be pulled upward by the tongue muscles. Now the mucosa will be opened. First an incision below the hyoid is made. This part of the mucosa corresponds with the interspace between the epiglottis and the tongue-base. The length of the opening is in accordance with the distance between the two points where the hyoid bone has been severed. The second incision is made above the hyoid extending similarly to the severed parts of the bone above the hyoid bone. Finally the mucosa is incised vertically through the sawing line whereby the pharyngeal cavity is widely open, the two lateral mucosal incisions and the medial one having become contiguous. The hyoid bone fixed hitherto may now be allowed to be pulled upward by the tongue muscles. The mylohyoid muscle having its insertion near the inferior margin of the hyoid bone, its inferior and posterior aspect is turned forward simultaneously.

The exposure admitting a free inspection toward the aditus of the larynx is strikingly good. The hyoid bone having been pulled upward nothing covers the aditus. The same may be stated as to the upward insight. Naturally, the visual field of the aditus may still be widened by retracting the great cornu of the hyoid bone.

It has been mentioned above that in cases often attended by abundant bleeding such as operations on the tonsils and the tongue base aspiration should be prevented by preoperative proceedings the essential features of which have been published in one of my previous papers on controlling laryngeal bleeding. On tracheotomy, a little pantocain-adrenalin solution is injected through a needle, prior to opening the trachea, into the trachea whereby it becomes anæsthetized. Following pharyngotomy the aditus is anæsthesized by pantocain spray. The liquid flowing down into the pharynx is mopped up by gauze. Now a Bellocque sound is led through the tracheotomy upward into the air-tube, then pressure is exerted on the Bellocque spring to bring the knob of the spring into the pharyngotomy wound. A double silk thread bearing a pear-shaped tampon is fastened around the knob, the spring pulled inward, the Bellocque sound removed and the tampon drawn into the aditus by means of the silk threads having left the air pipe lumen through the tracheotomy, simultaneously the threads are tied together over a piece of wood lying upon the cannula. A small cylindric piece of wood with a circular notch at its middle is suitable for this purpose.

If the essential part of the operation is to be continued within the

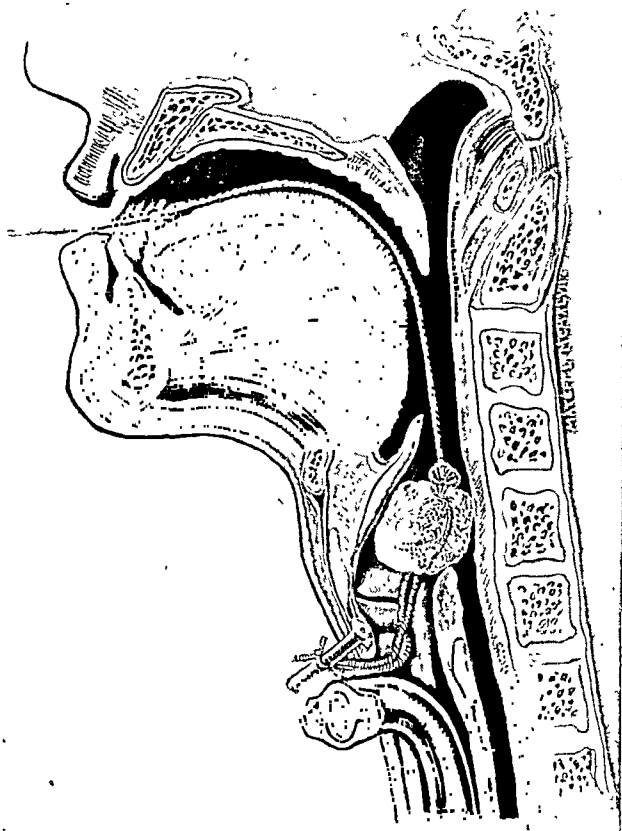


FIG 3

Former procedure of the author To control bleeding in the aditus tracheotomy is performed, a swab is pulled through the mouth into the aditus by means of a Belloccque sound the pulling cords are fastened in front of the tracheostoma Any operation following pharyngotomy is preceded by the same procedure apart from the fact that the swab is introduced through, or kept ready in front of, the opening of the operation

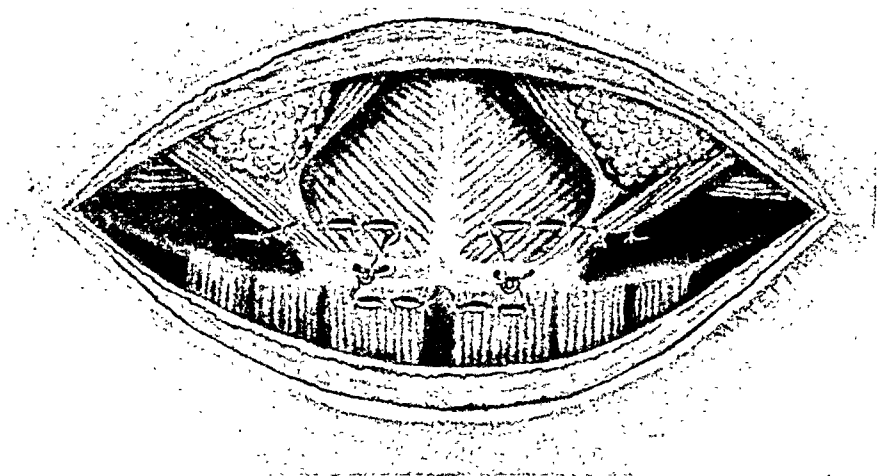


FIG. 4.

Muscle and bone suture. The greater cornua are fastened toward the larynx by the unsevered soft parts. The strong tongue muscles have been left in their attachment to the hyoid bone. The bone suture prevents the wound from separation.

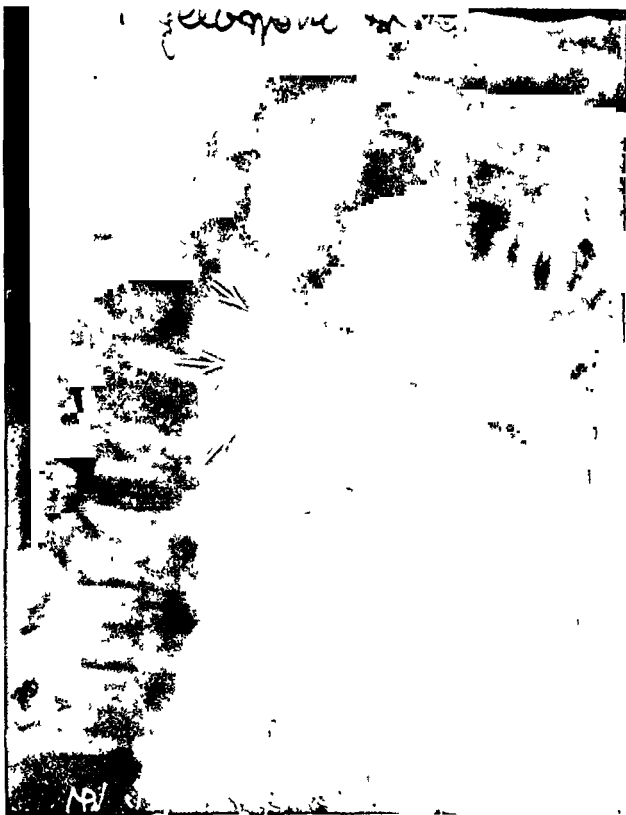


FIG 5

Film taken from the patient K I The arrows show the borders of the struma of the tongue basis



FIG. 6.

After operation the opaque substance shows that the contours of the tongue basis have been preserved intact.

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aditus of the larynx the tampon must not be drawn inward except in the case of intensive bleeding, otherwise it is left hanging at the end of a long silk outside the pharynx. In these cases the tampon can be left in place also after the operation but it must be furnished with a third silk thread which will be lead out through the mouth and fastened there. Thus the tampon can easily be removed. If a large wound has remained uncovered and the lungs are to be protected from the occasional wound secretion the change of the tampon may be facilitated by fastening a silk thread of proper length to the inward drawing threads tied over the tracheotomy so that the tampon may be drawn to the front of the mouth and readily changed.

After the final stage of the operation, when bleeding has been adequately controlled and the mucosa wound cut in the course of the operation sutured, the tampon is removed and the wound of the pharyngotomy closed.

The excised hyoid bone is fastened by means of wire sutures. First a hole is made with a fine drill on both sides, both in the excised pieces and the ones left in place. In the neighbourhood of the place where the drill is working the bone must be free of any muscle tissue lest the drill hurt the muscle. First the pharynx mucosa is united with fine catgut stitches which should not if possible, include the whole mucosa, with knots facing the wound. After the mucosa has been united thin wire is passed into the holes on both sides in such a way that the wire ends look forward. The latter are grasped with a forceps and twisted up, the superfluous ends cut short and the twisted stump bent downward forming a loop. The hyothyroid ligament is sutured with strong catgut, afterwards the muscles are united both above and below the hyoid bone. A thin glass tube is put under the muscles on both sides. Fascia, subcutaneous fat tissue and skin are united, later with clips. Two days later the tubes will be replaced by gauze strips. Clips are removed on the third day and gauze strips saturated with collodion are placed on the wound. *Uneventful, primary wound healing follows after this operation* because, unlike the suprahyoid pharyngotomy, the tongue muscles have not been dissected off the hyoid bone, they do not retract, the larynx will not descend being retained by the united bone. The method has also some advantages compared with the subhyoid pharyngotomy: the greater cornua keep their connection with the epilaryngeal region (the membrane has not been divided here) and hold the hyoid bone more firmly than in a case operated with division of the soft parts below the greater cornua. Thus the superior laryngeal nerve cannot be hurt. Whereas the old methods especially the suprahyoid pharyngotomy left a wound taking several weeks to heal, here a primary healing may be expected. A special stress is to be laid on the advantages of the method in dealing with the alterations of the base of the tongue. Frequently a temporary

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resection of the mandible is performed by the surgeon to obtain a proper inspection. Though an inspection down to the epiglottis is granted by this technic the opening is so narrow as to raise technical difficulties in operating on the tongue base. As against this, transverse pharyngotomy yields when correctly performed a broad and clear insight. The tamponade described above prevents aspiration. If bleeding is severe the laryngeal artery lying near the wound margin may be tied in a few seconds.

Appendix

TWO CASES OF LARGE TONGUE BASE STRUMA OPERATED THROUGH PHARYNGOTOMY

Tongue base struma is a rather rare condition. Still more infrequent are those cases attended by deglutitional as well as respiratory disturbances. According to the old experience on "duplicity of cases" there were two cases of tongue base struma being nursed in this department at the same time. Both suffered from dyspnoea wherefore in one of them tracheotomy was an emergency operation on admission. In the second case dyspnoea became alleviated and tracheotomy could be postponed. Both cases were severe from clinical viewpoint since the apple-sized tumour could not be removed through the mouth and pharyngotomy seemed to be the only approach. In view of the equal severity of the two cases, one has been operated through suprahyoid pharyngotomy, the other through "transverse pharyngotomy" described in another paper of mine, in order to see the value of both procedures on the basis of two patients admitting of a correct comparison.

CASE I.—April 1st, 1946. The 44 years old female patient had experienced impaired deglutition for ten years. Complaints became gradually worse. In the course of the last year prior to admission her general condition deteriorated and her voice had changed. In the last two months she often had cough attacks after swallowing and severe dyspnoea, she could only sleep in a sitting position. She also had palpitation.

Present status: an almost cachectic woman with stridorous respiration. The tongue base was, starting from the circumvallate papillae, replaced by a tumour preventing laryngoscopy. There was no thyroid gland in the neck.

April 2nd, 1946. There was an increasing dyspnoea necessitating tracheotomy. In order to secure the field for pharyngotomy to be performed later inferior tracheotomy was done.

Medical examination revealed heart dilatation and myocardial insufficiency, digitalis and strophanthin were administered.

April 20th. The tracheotomy wound was free from reaction.

Medical treatment was continued.

General condition and heart failure improved but slowly. Finally, the operation planned was performed on June 28th. A typical suprahyoid



FIG. 7

The wire suture of the hyoid bone after healing

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pharyngotomy was induced under local anæsthesia. The pharynx was opened without considerable bleeding and soon the enormous goitre could be seen. Through the tracheotomy opening a Bellocque tube was introduced into the trachea anæsthesized with pantocain and a tampon pulled into the aditus by means of the tube. Having prevented blood aspiration in this way the base and the free surface of the goitre was infiltrated with a 0.5 per cent novocaine solution. The first incision was made at the tongue base parallel to the pharyngotomic wound, leaving a mucosa interspace of 1.5 cm. The second incision was a sagittal one severing the mucosa in the middle line along the whole length of the tumour. Thus there was a T-shaped incision present. The tumour was freed without serious bleeding by stitching a thick silk thread into the part of the tumour already deprived of its mucosa and pulling its anterior part under moderate traction into the foreground. The tumour was removed, only a thin layer of thyroid tissue being left in place. Then the mucosa dilated by the struma was removed and the T-wound closed by catgut. Then followed removal of the tampon, suturing of the pharyngeal mucosa, introduction of tubes on both sides, uniting of muscles, fascia, and skin, introduction of a Nelaton tube through the nose for feeding.

In the afternoon strophanthin, dextrose and sympatol were given.

June 29th Slight elevation of temperature.

June 30th Both submandibular regions were markedly swollen.

July 1st Removing of clips, replacing of the tubes by gauze strips. The tongue base was covered by fur.

July 9th Abundant purulent discharge from both wound angles. Introduction of tubes again.

July 15th Fistula allowing pus to escape in the middle of the wound.

July 25th Unchanged suppuration. Descensus laryngis due to sound separation, therefore impaired deglutition.

August 5th Diminished suppuration, replacement of the tubes by gauze strips, removal of the feeding catheter as deglutition improved.

August 10th Slight suppuration, removal of the tracheal cannula. The tongue base was on that day smooth, without any protuberance.

August 15th No suppuration, closed fistulae, nearly healed tracheotomy wound.

August 17th Patient cured, dismissed.

CASE II —A woman aged 41 was admitted on June 25th, 1946. She had had swallowing difficulties for five years, painful deglutition for one year, dyspnœa for two months. For the last three days she was very ill.

Status on admission: there was an apple-sized tumour at the tongue base preventing laryngoscopy. The tumour had a hyperæmic surface. Dyspnœa (stridorous respiration) was present. No thyroid could be detected in the neck. Strumitis was assumed. Medical examination revealed a chronic bronchitis and heart failure. Expectoants and digitalis were administered. In four days reduction of the struma and improved respiration could be observed.

July 11th Operation under local anæsthesia. First an inferior tracheotomy was performed (the absence of the thyroid represents a real facility!).

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then transverse pharyngotomy (Réthi). A tampon was pulled into the aditus by means of a Bellocque tube. The struma was removed as in Case I. Uniting of the wound took place as usually with this operation. Tubes were introduced on both sides.

July 13th. No wound reaction, removal of the tubes, introduction of gauze strips.

July 15th. Removing of the clips, securing of the wound by collodion strips.

July 17th. Minimum of discharge through the strips. It could be established that there was some swelling of the tongue base but no descent of the larynx.

July 19th. Removal of the strips.

July 21st. Removal of the feeding tube.

July 24th. Removal of the tracheotomy tube.

SUMMARY

Two equally severe cases of tongue base goitre were nursed in the same ward at the same time. Strumectomy was unavoidable in both cases. In one of them suprahyoid pharyngotomy, in the other transverse pharyngotomy published recently by the author of this paper was performed. In the first case operation was followed by a suppuration lasting for seven weeks in course of which also descensus laryngis occurred. In contra-distinction to this, healing was uneventful in the second instance. The advantage of transverse pharyngotomy becomes evident when the case reports are compared.

THE TREATMENT OF INFLAMMATIONS OF THE INNER EAR BY SULFA-DRUGS

By A A J VAN EGMOND and L B W JONGKEES (Utrecht)

SOME years ago statistics on the results of conservative treatment of patients with otitis interna were published by the present writers. In this it was pointed out that the conservative treatment, i.e. the absolute avoidance of every operative procedure on the labyrinth itself, gives results definitely not inferior to the results of a more aggressive method of treatment. The publishing of this statistic, entirely dealing with the period in which the chemotherapeutics were not yet in use in our clinic, might seem superfluous, because the new drugs will undoubtedly change the treatment of the otitis interna in a conservative direction. Nevertheless this statistic was purposely published just at the beginning of the era of the sulfa-drugs, in the same way as this new publication comes out at the beginning of another new period, the period of penicillin therapy.

The good results of the sulfa-drugs cannot be denied but we should not give them more honour than they deserve. As a result of their experiences many authors are beginning to be more conservative with the help of those drugs than they dared be beforehand. In addition to the effect of the drugs we consider the conservative treatment a second favourable factor.

We hope to demonstrate with the help of the following article that a labyrinth operation is never or hardly ever indicated. We are sure that this operation in the era of the sulfa-drugs and a fortiori in that of penicillin and even newer biochemicals soon ought to belong to the obsolete operations.

Moreover the literature after 1935 contains many publications of otologists who adopt a more conservative attitude, even though their reasons for this attitude differ. To most of them the knowledge of the existence of the sulfa-drugs seems to give them more courage to await complications from the meninges and eventually to combat them. Though before 1935 we came across many case reports in the otological literature of patients who recovered as a result of a labyrinthectomy, nowadays many reports are given of inflammations of the inner ear, even complicated with meningitis, which recovered without an operation of the labyrinth.

The old Viennese indication of Ruttin (for the older literature see the previous article by the present writers) that in every case of otitis interna causing a loss of the function of the labyrinth (i.e. deaf and

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not reacting to caloric stimulation) a labyrinthectomy has to be performed by one of the many methods described for that purpose, is no longer followed at present. A complete labyrinthitis complicating an acute otitis media in the first days of its course, a scarlet fever or a tuberculous otitis media is no longer an indication in itself.

Besides, the finding of a dead inner ear without acute labyrinthogenic symptoms and with compensation at the examination with the rotating chair according to Bárány is no reason to attack the labyrinth.

The reason for the Viennese indication is that no control is possible of the proceeding of the inflammation towards the meninges if the labyrinth doesn't function any more.

As for most investigators an inner ear without function is a dead inner ear, they don't see any sense in saving it. This is the reason why they remove this source of infection as thoroughly as possible.

That things are not as simple as expounded above and that the division of Ruttin into a serous and purulent labyrinthitis has no pathologic-anatomical basis at all is shown by the fact, that many so-called purulent labyrinthitides are able to heal with recovery of function (c.f. Grove and Strauss, Capps, Pogany, Jongkees) and on the other hand, that a so-called serous labyrinth-inflammation with functioning of both parts of the inner ear may give rise to a purulent meningitis.

These reflections have led to another basis for labyrinthectomy. Many investigators with Lund as their interpreter, direct their attention to an inflammatory reaction in the cerebrospinal fluid as soon as the smallest sign of a complication is or seems to be present. At a fixed maximum of cells in this fluid (for Lund $6/3$ cells/cm.) they open the labyrinth independently of its function. They agree with Alexander, that an uncomplicated labyrinthitis has an absolutely favourable prognosis.

Then there are the more conservative minded otologists, who only open the labyrinth in cases of definite meningitis (Cinelli, Eschweiler, Marx, Scheibe, Tsimeas) or even not before the meningitis is septic (Blackwell, Harris, Quix, Reverchon and Worms, Uckermann).

Finally we have to mention those otologists, who do not believe in any operation on the labyrinth. Lange in Vienna declared in 1927 that he had never lost a patient because a labyrinthectomy was not performed. In the clinic of the Utrecht Otological Department no labyrinthectomy has been performed for the last twenty years, in cases of labyrinthitis or meningitis.

In the treatment of labyrinthitis the most remarkable fact is not that some otologists have a wider indication than others for undertaking an operation on the inner ear, but that exactly those, who are very aggressive regarding the inflamed labyrinth, are very conservative when smaller operations come into question. The mastoidectomy and the radical operation, highly esteemed by many observers as evacuating

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operations, are considered by them as dangerous actions easily capable of causing an extension of the inflammatory process. For most observers, even for the defenders of the Viennese indication an operation on the labyrinth is dangerous and superfluous as long as some function is left, because by this operation adhesions may be destroyed and the general resistance diminished. However as soon as no more function can be shown, the immediate opening of the labyrinth should be without danger, though in both cases the pathological substrata in the inner ear may be almost identical.

We can't understand why there should be any difference in the danger in either case. The danger of every operation on the middle or inner ear seems to us to be of rather the same character. At most, the more difficult the operation, the greater the danger, and the operation on the inner ear presents more difficulties than that of the middle ear. We have never seen any bad result from the radical operation or a mastoidectomy intended to attain an evacuation of pus, when the patient suffered from a labyrinthitis. However, the lateral wall of the labyrinth is always strictly left untouched. We consider sondage of the windows, scraping off of granulations and such actions to be as dangerous as every operation on the labyrinth. Therefore we cannot possibly agree with P. Mysel, who is of the opinion, that a radical operation aggravates the trouble when the inner ear is inflamed. On the contrary we consider an inflammation of the labyrinth a complementary indication for performing a radical operation though it is never the sole indication for us.

It appears from the discussion at the meeting of the Royal Society of Medicine Section of Otology in the year 1944 following the speech of Watkyn Thomas, who himself rejects the labyrinth operation in cases of acute otitis media as being useless that otologists are existent who are even more conservative than we. On this occasion F. McGuckin declared that he never opened a labyrinth and attributed the few cases of purulent labyrinthitis which occurred to that fact, because very often the function of this organ returns if we only wait quietly without any operative action. D. Watson is still more conservative. He does not examine the vestibular function if an inflammation seems probable nor does Norton Canfield. Stirk Adams gives an example of a living inner ear causing a meningitis after the caloric examination.

We do not share this extremely conservative point of view as we have never seen any bad consequences of a caloric examination performed with care, which moreover may provide us with prognostic data of great value. On the other hand we avoid the examination on the revolving chair according to the method of Barany because the extremely great accelerations may very well damage the structure of the diseased labyrinth whereas the data obtainable by this examination are of little value in the prognosis and treatment. Even a sound vestibular organ is considerably damaged by

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this method of examination, as we were able to demonstrate and hope to publish soon.

Whereas on former occasions before the use of sulfa-drugs we used to be strictly conservative in the treatment of the inflammations of the labyrinth on account of the good results obtained in that way, in the era of the chemo- and biotherapeutics we persist in our attitude with the utmost certainty, once more on account of the following statistic.

To judge a statistic of cases of labyrinthitis it is necessary to divide this disease in its entirety into parts for classification in the same way as is done in other statistics. This is the only reason why we have followed the classification of the French School (Ramadier) and not because we expect to find the same pathological basis for one group. Therefore we avoid the Viennese classification which gives almost the same division but with names suggesting pathological conformity—serous and purulent labyrinthitis—with the clinical entities.

The French classification is as follows:—diffuse complete labyrinthitis—with conservation of the function of both parts of the labyrinth (hearing and caloric excitability); circumscript labyrinthitis—with loss of the function of one part of the inner ear;—diffuse complete labyrinthitis—with loss of the total function of the labyrinth.

In the era before the use of the sulfa-drugs the mortality of the first group was about 3 per cent., that of the circumscript labyrinthitis about 10 per cent., and for patients with total loss of function varying from 20 per cent. to 40 per cent. These are the average data from the literature up till about 1938, the treatment mostly being operative.

In the Clinic of the Utrecht University we have seen in a period of ten years (1930-1940) ten diffuse incomplete labyrinthitides with one death, 14 cases of circumscript labyrinthitis without one death and 20 cases of complete diffuse labyrinthitis with 3 deaths—all 44 cases the result of an inflammation of the middle ear. In none of these cases a labyrinthectomy had been performed, nor have sulfa-drugs been used.

The newest extensive statistic in the literature at our disposal is that by A. Jauerneck from 1943, in which the results of 64 labyrinth operations are given.

Of 22 uncomplicated cases which came for treatment 5 died; of 42 patients already with a meningitis when they came to hospital 26 died.

The division in chronic and acute inflammations of the middle ear was as follows:

27 labyrinthectomies were performed on account of an otitis media chronica complicated with a meningitis—14 died after the operation.

In 18 cases complicating an otitis media chronica but without a meningitis an operation was performed, 4 of these died.

Of 4 cases complicating an acute otitis without meningitis one died and of 15 patients, also suffering from a meningitis, 12 died.

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The indication for operating on the labyrinth was a combination of at least two of the following four data : (1) eliminated labyrinthine function , (2) symptoms of excitation of the vestibular organ ; (3) destruction of the lateral wall of the inner ear ; (4) meningitis.

Own Statistic

The 74 cases of inflammation of the labyrinth registered in our clinic since the sulfa-drugs have been put into use, gave the following results :

Cause	Total number	Classification			With meningitis	Death
		Diff incompl	Circumscri	Diff compl		
Chronic otitis media	51	21	7	23	10	4
Acute otitis media	13	4	3	6	6	2
Post operative	7	2	0	5	1	0
Scarlet fever	2	0	0	2	1	0
Tuberculous otitis media	1	1	0	0	0	0
Total	74	28	10	36	18	6

Of all patients with labyrinthitis admitted to the hospital without endocranial complications (56) not a single one died

Of those cases which came in with a complicatory meningitis (18) six had a lethal issue This is in accordance with the experience of P. Myzel, who states that the mortality of labyrinthogenic meningitis fell back from 92 per cent to 33 per cent since the use of sulfa-drugs

However, Myzel opens the labyrinth if a meningitis is present and we do not Nevertheless we believe that our statistic does not yet produce sufficient evidence of the value of the conservative treatment as compared to the operative one, for, of the patients who died as a result of a complicated labyrinthitis, one died within an hour after admission to hospital, one lived only for 4 hours, and one died before an operation could be performed at the beginning of the narcosis Of those who lived more than 24 hours under our care (that is after the sulfa-drugs could act) only 3 died

A short case report of all patients, who died of this disease follows at the end of this review

Moreover, as McGuckin remarks, we have to bear in mind the possibility of another origin of the meningitis for instance the affection of the tegmen area or the extension along the labyrinth In these cases the labyrinthitis may arise in consequence of the meningitis (Youngs and Lindsay) The many cases of absolute deafness as a result of epidemic meningitis show a distinct instance of this possibility

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Of the cases in our statistic 42 were men and 33 women. This prevalence of the male over the female sex is often described in the literature in all sorts of complications of the chronic inflammation of the middle ear.

One of us (J.) has pointed out, that this cannot possibly be the result of the greater dangers and exertions men have to endure, because in children under 10 years of age many more boys than girls have a chronic otitis, while for both sexes the number of acute inflammations is the same. He has then suggested the possibility of the influence of hormones, because we know by experience that more complications of a chronic otitis occur during pregnancy.

The age of the patients, suffering from a labyrinthitis varies from 3 to 79 years.

0-10 years	10-20 y.	20-30 y.	30-40 y.	40-50 y.	50-60 y.	> 60 y.
4	15	31	10	10	2	5

Consequently most cases occur in young adult life. No preference was found for either left or right side. 37 cases were on the left side and 38 cases on the right side.

The treatment in 26 cases was absolutely conservative. Ten patients underwent a mastoid operation and 37 a radical operation; 2 patients died before any treatment was possible.

Our conclusion from these data is that the *conservative* treatment of the patient in cases of labyrinthitis is the indicated treatment. The sulfa-drugs have not improved the prognosis of the closed labyrinthitis as this is decidedly favourable provided we leave the labyrinth alone (we haven't lost a single patient as a result of the disease since 1930).

The great value of the chemo- and biotherapeutics is their influence on the complicating meningitis. Likewise for these cases the labyrinthectomy has been made superfluous by the use of these drugs. To the statement by Alexander that a closed labyrinthitis is a disease without danger, but labyrinthectomy a dangerous operation, we assent completely.

For the following reasons we feel prompted to dissuade from any operation of the inner ear in cases of inflammation of the labyrinth:

(1) A labyrinth, that doesn't give signs of living may regain a function after healing.

(2) The chance of damaging the facial nerve is not inconsiderable, even in the hands of a skilled surgeon.

(3) It is not easy to avoid the damaging of adhesions, not as a result of the shock caused by the chiseling but by direct destruction. In cases of operation on the middle ear in which the lateral wall of the labyrinth was carefully respected we never saw the occurrence of a single accident.

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(4) The results of the most strictly conservative treatment of the labyrinth are better or at least as good as the results of a more aggressive treatment. Though it may be possible that once or twice a patient is saved by the opening of the labyrinth (a causal conclusion to be taken with the utmost caution) it is certain, that patients have died as a direct result of this action.

The steadily growing conservatism on this account surely is a proof of partial dissatisfaction with the labyrinthectomy. In case a conservative and a operative treatment meet with as much or as little success (c f Dohlman, who declares that a labyrinth operation in cases of inner-ear inflammation as a result of an acute middle-ear suppuration is as useless as a conservative treatment) then surely the conservative treatment is preferable to the operation, as with the former the danger of damaging the facial nerve does not exist and on the other hand a partial return of the function of the diseased organ is possible.

We treat the patients who suffer from a labyrinthitis in the following way:

Strict confinement to bed, regular control of the temperature and the general condition, and control of the cerebrospinal fluid at the slightest suspicion of something unusual.

In case of an irritation shown by the increase of the albumen content or an augmentation of the cells, sulfa-drugs are administered mostly as sulfapyridin, sulfanilamide or sulfathiazol (dagenan, prontosil, cibazol) 6 grammes a day with a first dose of 3 grammes. Besides a mastoid or radical operation is performed, according to the basic middle-ear deviation with scrupulous avoidance of the lateral wall of the labyrinth.

The operation is performed with chisels under nitrous oxidether narcosis.

During the 15 years of this and the previous investigation we have never seen any disadvantage as a result of those evacuating operations.

The confinement to bed and the use of the sulfa drugs are maintained for a long time.

Case Reports

CASE I—A boy, 5 years old got ill with a cold and an earache a week ago. The ear discharged some pus. The family doctor gave him sulfa drugs three times 300 mgr daily.

On May 12th, 1940, he comes to us extremely ill. The right mastoid region is tender and swollen. The temperature is 104° . There is nuchal rigidity and a positive Kernigs sign. In the cerebrospinal fluid are 7,000/3 cells, positive albumen reactions and *bacillus crassus*.

The right ear is deaf but reacts on caloric stimulation with cold and hot water with normal nystagmic reactions. No spontaneous nystagmus is found. Sulfathiazol therapy is instituted immediately (2 grammes first dose, every four hours 0.5 grammes).

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Stokes respiration, absent tendon reflexes, no nuchal rigidity Both inner ears are dead (deaf and not reacting to caloric stimulation) No spontaneous nystagmus There is but a small amount of pus discharging from the left ear Three grammes of sulfapyridin are administered intravenously

Operation on the mastoid without anaesthesia Much pus under high tension is found in the mastoid cells The patient dies in the theatre

Post-mortem examination Extensive meningitis caused by pneumococcus No abscess is found in the brain Dura over the left tegmen area seems discoloured

Microscopic examination of both inner ears Both inner ears turn out to be normal The membranes of the round and oval windows are intact In the left middle-ear inflammatory reactions and pus are found

Conclusions An acute middle ear inflammation gave rise to a meningitis without involving the labyrinth The seemingly dead labyrinths were histologically normal Meningitis caused by an otitis media acuta following a parabyrinthine route

CASE IV —A woman aged 20 has a discharging left ear since childhood A fortnight ago she began to complain of a headache Three days ago she had vertigo and vomited On admission to the hospital on 28.5.43 the right ear proved to be normal In the left ear a big polypus made any inspection of the drum impossible This left ear is deaf and does not react on stimulation with cold (iced) water, nor hot water There is a slight paresis of the left facial nerve No signs which demonstrate a labyrinth stimulation are present no spontaneous nystagmus no deviations in walking with closed eyes, no neurological signs, nevertheless the cerebrospinal fluid contains 20,000/3 cells/cm and the albumen reactions are strongly positive Streptococci are found in great amount The general condition is bad

Radical middle-ear operation shows a big mass of cholesteatoma and a fistula in the horizontal canal In Trautmann's triangle the dura appears to be diseased (discoloured)

Sulfapyridin is given orally in high quantity after the operation the condition deteriorates though the total amount of cells decreases as well as the tension (31.5 6,000/3 cells/c mm) 2.6 death

Post-mortem examination A perforation as large as a pencil is found in the dura, through which a communication of the cranium with the diseased middle ear is possible No general meningitis is found but in many places accumulations of pus are present, for instance in the fossa of Sylvius between the hemispheres of the cerebellum, against the left hemisphere of the cerebrum, and in the left porus acusticus internus Streptococci staphylococci and bacilli are present

Diagnosis Meningitis caused by a direct perforation through the dura above a chronically inflamed left middle ear

Microscopic examination of the left petrous bone There is a diffuse destruction of the inner ear, with partial organization of pus in the cochlea and the vestibule In the semicircular canals an albuminous deposit is found There is an inward luxation of the stapes footplate

Diagnosis A labyrinthitis of long standing

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Conclusion. A chronic inflammation of the middle ear caused a labyrinthitis and a meningitis. The direct communication from the middle ear through its roof to the meninges makes it improbable, that the labyrinthitis was the cause of the meningitis. Meningitis caused by a chronic otitis media, complicated by a diffuse complete labyrinthitis.

CASE V.—A girl 17 years old has a discharging right ear for five weeks. For four days she complains of a headache and is vomiting. Yesterday her family doctor found a facial palsy and nuchal rigidity. She never made any complaint about dizziness. On admission to the hospital on 15.5.44 the girl is very ill and unconscious, with normal temperature. In the right ear no part of the drum is to be found, a big mass of cholesteatoma fills the middle ear. The hearing acuity cannot be measured, because the patient is unconscious. Caloric stimulation gives no response. There are no spontaneous vestibular symptoms. In the cerebrospinal fluid 7,500/3 cells/cm. are found, especially granulocytes. Bacillus influenzae is found as producer of the inflammation.

After injection of three grammes of sulfathiazol intramuscularly *radical operation* of the right ear is performed without anaesthesia. A big mass of cholesteatoma is found by which the horizontal canal and a part of the promontory has been destroyed. The patient dies four hours after admission to the hospital.

Post-mortem examination of the right petrous bone. There is great destruction of the lateral wall of the labyrinth. No trace is found of the stapes or the oval window, the facial nerve is surrounded by cholesteatoma. The rest of the inner ear is filled with partially organized pus and albuminous deposit.

Conclusion. A chronic middle-ear inflammation gives rise to a meningitis, making its way through the labyrinth. It is remarkable, that this patient never knew that she had a diseased ear till some weeks before death. Otitis media chronica cholesteatomatosa complicated with a chronic labyrinthitis and a meningitis.

CASE VI.—A woman aged 20 has a discharging ear on the right since early childhood. Last year she had attacks of headache. Two weeks ago she became dizzy with severe headache in the back of the head.

On admission to hospital (13.1.45) a perforation of Shrapnell's membrane is found in the right ear. The inner ear seems to be dead on that side. No spontaneous symptoms of irritation of the labyrinth.

Neurological examination shows slight irritation of the meninges. Temperature 98.5°. In the cerebrospinal fluid much albumen and 160/3 cells/cm. are found. There are no local symptoms of an abscess in the cranium, though this is strongly suspected on account of the headache and the condition of the cerebrospinal fluid. The papillae opticae are normal.

At the radical operation of the middle ear a great mass of cholesteatoma is found. Cibazol is given, 6 grammes a day.

17.1.45. Temperature normal; no papilloedema; no headache. General condition worse. No local symptoms of an abscess of the brain.

31.1.45. Vomiting for some hours. Ataxia on the left; general condition bad. The patient is brought to the theatre to try to drain the

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suspected abscess in the cerebellum Before anything could be done, the patient dies in the theatre

Post-mortem examination shows a big abscess in the right hemisphere of the cerebellum, with very little capsule formation No meningitis

Microscopic examination of the right inner ear shows a diffuse inflammation of all the parts of the inner ear A luxation of the stapes seems to be the way of infection

Conclusion A chronic cholesteatoma of the right ear gave rise to an abscess of the brain, probably via a labyrinthitis Otitis media cholesteatomatosa dextra with abscessus cerebelli and labyrinthitis

CASE VII—A man aged 27 is ill with influenza since three days He had earache two days ago and a discharge from this ear the day before admission to the hospital As a boy he had had a discharging ear but on which side is unknown No dizziness

13 3 45 *Hospitalization* The restless and almost unconscious patient has a foul smelling discharge from his left ear from an anterior perforation The left labyrinth does not react on caloric stimulation The hearing function cannot be determined No nuchal rigidity nor Kernig's sign but in the cerebrospinal fluid are countless cells, mostly of the polynuclear type

Sulfapyridin, 3 grammes, is given intramuscularly

Mastoid operation under ether-anæsthesia reveals a chronic process with destruction of bone The radical operation is performed The dura is denuded and discoloured The condition grows worse quickly and the following morning the patient dies

Post mortem examination Purulent meningitis especially on the left basal side, thick green-yellow pus with streptococci An extensive osteomyelitic process of the whole petrous bone is found There is no thrombosis of the lateral sinus, nor an abscess of the brain

Microscopic examination In preparation the bone is damaged too much to be of any use

Conclusion An otogenic meningitis caused by an osteomyelitis of the petrous bone having caused a labyrinthitis at the same time The cause of the osteomyelitis is a chronic non-cholesteatomic middle ear inflammation We doubt whether the labyrinthitis is the direct cause of the meningitis This seems very unlikely (cf the case described by Youngs and Lindsay), because the osteomyelitis had affected the whole petrous bone Otitis media chronica non-cholesteatomatosa with osteomyelitis ossis petrosi giving rise to a labyrinthitis completa diffusa and a meningitis

Summarizing the cases of labyrinthitis causing death through an intracranial complication, we find three deaths as a complication of an acute otitis media and four deaths as a complication of a chronic otitis media Case III may be omitted from this statistic because the inner ear was found to be normal on histological examination

Of the other 6 lethal cases 3 died within 24 hours (Cases II, V and VII), an operation of the inner ear could hardly have changed this fatal issue

The patients who lived long enough after admission to hospital (I, IV and VI) might have been operated on their inner ears

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In Case I the still living inner ear makes no strong indication. Further the very bad prognosis of the intracranially complicated labyrinthitis in the second week of an acute middle-ear inflammation is known also for the operative method (Dohlman).

In Case IV the direct communication makes it probable that the infection followed this way, but the operation on the labyrinth is not tried, so we cannot be certain of its eventual result.

In Case VI the abscess in the cerebellum predominates. Perhaps an earlier localization of the abscess and drainage might have saved the patient. We do not believe that a labyrinthectomy could have altered the course of the disease.

In the Cases II and VII some doubt exists of the labyrinthine origin of the intracranial complication; in CASE II on account of the longer standing of intracranial complaints in comparison to the labyrinthine complaints; in Case VII the general osteomyelitis is a more probable cause of the meningitis than a labyrinthitis of which no symptoms could be found, only no reaction on caloric stimulation.

As at the making of statistics there always is a danger of partiality on the side of the authors on account of their personal view, we have presented those cases of death in which a labyrinthitis might have existed, so the reader may judge for himself.

In all those cases the patients were thoroughly examined but only the parts of interest for the reader are presented for shortness. We hope that we have omitted nothing of importance for the valuation of the cases.

Summary

On the basis of 74 cases of labyrinthitis, under conservative treatment as far as the inner ear is concerned, the prognosis of the labyrinthitis is discussed. Already before the use of sulfa drugs the recovery of uncomplicated labyrinthitis was a rule. The chemotherapeutics didn't alter the prognosis in the least. All the cases (51) under our care recovered.

The prognosis of the cases complicated with meningitis is greatly improved by the use of the sulfa-drugs.

Eighteen cases were admitted to hospital with an intracranial complication. Six patients died, but 3 of them lived less than 24 hours, which means that they died before the drugs could have taken effect.

In 7 case reports the possibility of the benefit of an operative treatment (labyrinthectomy) is judged. Only in one case (IV) a very slight possibility is admitted.

Stress is laid upon the fact that a labyrinthectomy isn't properly indicated any longer, because this operation does not improve the prognosis and added to the dangers of every operation on the ear has a chance of damaging the facial nerve and of causing the impossibility of a restoration of the function of hearing or equilibrium.

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CLINICAL RECORDS

A CASE OF GAS-FILLED ABSCESS IN THE TEMPORAL LOBE

By WILLIAM MCKENZIE (London)

THIS case is recorded to show the striking X-rays, which were taken by chance before exploration of the brain.

H.V., aged 45 years, was admitted to the Royal National Throat, Nose and Ear Hospital for myringotomy on *September 8th, 1947*.

He had complained of deafness for a fortnight, but there had been no discharge. The drum was œdematous, and he could only hear a loud shout on this side. There was no discharge after myringotomy, and the incision healed quickly without relief of symptoms. A week later he was admitted for exploration of the mastoid.

This was undertaken on *September 20th*, when a generalized infection was found. He seemed to do well after this, although his deafness did not improve but ten days later he complained suddenly of headache and photophobia.

Dr. L. R. Yealland, neurologist to the hospital, saw him at this time, and made the diagnosis of a left temporal lobe abscess. X-ray photograph of the skull showed the remarkable picture of a gas-filled abscess with a fluid level (Figs. 1 and 2). The radiographer has, unfortunately, placed a mark over the abscess in the film. This abscess was not visible in the X-rays taken before mastoidectomy ten days earlier.

The mastoid cavity was reopened on *October 10th*, when the abscess was tapped quite easily with a brain needle. The gas escaped under pressure, followed by about 5 c.c. of straw-coloured fluid, which was sterile. This fluid was replaced by Thorotrast, which shows well in the X-rays (Figs. 3 and 4). The larger mass is the bipp pack in the mastoid wound.

A week later the abscess could not be found by the brain needle, although X-ray showed no change in the size or shape.

I have to thank Dr. T. V. B. Crichlow, radiologist to the hospital, for the X-ray photographs.

A CASE OF GAS FILLED ABSCESS IN THE TEMPORAL LOBE—
WILLIAM MCKENZIE



FIG 1



FIG. 2.

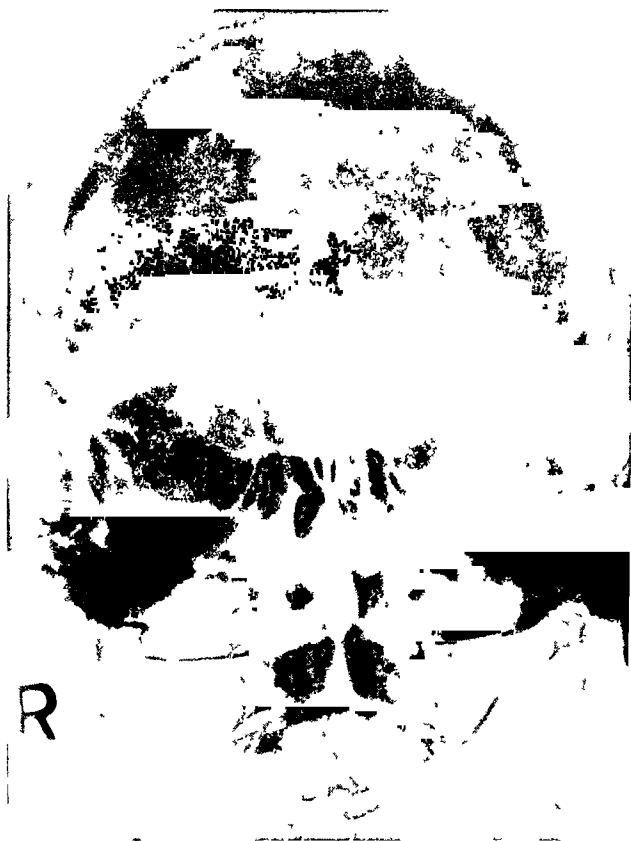


FIG 3



FIG 4

A CASE OF SUBMUCOUS ABSCESS OF THE ŒSOPHAGUS

By J V CLARK (Tunbridge Wells)

PRIVATE P, aged 24 years, had been in a military hospital in India for four months, undergoing treatment for an injury to his knee joint following an accident in an Army truck. This injury had been treated by rest and subsequent physiotherapy.

During convalescence, he developed a sore throat, which was diagnosed as mild tonsillitis with adenitis. A culture was taken at this time, and the report read "No K L B. No Vincent's organisms seen." The patient was put on a simple routine of gargles and, by the third day, the sore throat had settled but, by then, he complained of difficulty in swallowing. This dysphagia was so severe that he was only able to swallow fluids, and could manage no solid food at all. Although apyrexial, and suffering no other discomfort, the dysphagia persisted. Two days later, he was given a barium swallow (see X ray, Fig 1).

This was reported on as follows —

"There is marked narrowing of the œsophagus, beginning at the level of the disc between D8 and D9, and involving the succeeding 2 inches of the œsophagus. The narrowing is smooth and regular. There is well marked dilatation of the œsophagus above the lesion, and peristalsis is active in the dilated section.

"The appearance is of a simple stricture rather than spasm, and the condition, judging by the degree of dilatation, is of much longer standing than the history suggests. Spasm of this part of the œsophagus is usually due to recent trauma or ulceration.

"Idiopathic spasm has been described, but it is extremely rare. In any case, spasm is usually local, and not segmental.

"The most likely explanation is that this is an old and, until recently, compensated simple stricture, due either to a congenital abnormality, or to an unremembered trauma.

"Further evidence for or against spasm could be obtained by putting the patient on full doses of belladonna for a week, and re-examining after that interval."

N A LAWLER, Lt-Col, R A M C

After one week's treatment with belladonna at four hourly intervals, there was no change in the patient's ability to swallow, and re X-ray at this time showed no changes since the previous examination. At this stage, I was asked to see this patient, and carry out an œsophagoscopy. My findings were as follows —

Œsophagoscopy

At a distance of 28 cm from the upper incisor teeth, the œsophagus appeared narrowed antero-posteriorly, and only the anterior wall moved on

respiration. At 30 cm., a total obstruction was encountered. This obstruction presented as a concentric spongy constriction, in the centre of which lay a thick yellow membrane. The membrane was peeled out, and removed with forceps. Immediately, 10-15 c.c. of turbid fluid drained away, as a slow trickle. Specimens of this were collected. In spite of this amount of fluid being drained off, the stricture persisted. The walls of the stricture felt soft, and a narrow channel was now visible. It was evident that the obstruction was due to an abscess, either submucosal or periesophageal.

The X-rays were very carefully re-studied, and it was noted in one picture (see X-ray, Fig. 2) that the outline of the oesophageal wall could, in fact, be traced through in the normal line (see arrow): and it was evident that the obstruction was caused by swelling within the walls, and not by any periesophageal collection with secondary oesophageal compression.

The Laboratory Report on the fluid was as follows:—

“The fluid contained mainly polymorphs and streptococci on direct examination.

“The streptococci have not grown on culture, and are either anaerobic or dead. I am now trying to grow them anaerobically.”

M. O. BEATTIE, Major, R.A.M.C.

(No sulphonamide or penicillin had been given, up to this time.)

Unfortunately this anaerobic culture was never received.

The diagnosis, therefore, was established at this stage as a submucous abscess of the oesophagus. It was very difficult to understand how this abscess had been caused, but possibilities would seem to be as below.

(a) As Colonel Lawler had originally suggested, that there existed an underlying simple stricture (previously compensated), due either to a congenital abnormality, or to an unremembered trauma. The unhealthy mucous membrane at the site of the holdup had then become infected with the organisms responsible for the sore throat, leading to the development of a submucous abscess. However, the subsequent “cure” of the stricture to such a degree on barium swallow, there was no hold-up and peristalsis again became normal in the stricture site, would appear to me to negative this theory.

Submucous hæmorrhage, caused by trauma, with later secondary infection and infection, might be considered as a cause. The painless onset of this unlikely, for the only case of this sort which I have seen was dealt with by me very recently: the onset of dysphagia was characterized by extreme pain, which persisted for five days, and symptoms were so marked as to demand urgent investigation.

(c) Some small abrasion of the oesophagus, due to a foreign body ingested with his food, might similarly have become infected with these same organisms, with the subsequent formation of an abscess.

It would seem that this point will never be proven, as the patient eventually developed an almost complete fibrous stricture of the oesophagus.

It had been hoped that draining off the fluid contained in this abscess might have resulted in some ability to swallow. However, after waiting another four



FIG 1

Clinical Records

days, it was evident that this was not to be the case, and a gastrostomy was performed. The patient's condition rapidly improved, but only fluids could be swallowed by mouth.

Seven weeks later, a further barium meal was given, and X-ray showed hold-up to be more marked than before (see X-ray, Fig. 3).

Œsophagoscopy was again performed at this stage, when it was found that all the swelling originally present had subsided, but there was a tight stricture 30 cm. from the incisor teeth, through which the smallest Chevaier Jackson dilator failed to pass.

The following treatment adopted had to be carried out with improvised apparatus, as no standard bougies were available.

The patient was given a length of silk thread to swallow and, three days later, a small bronchoscope was slipped through the gastrostomy opening, and the silk thread recovered quite easily from the stomach. To this silk, a stouter thread was carefully spliced, and drawn gently through the œsophagus, and out through the gastrostomy opening. A No. 5 rubber catheter was threaded to the thread, and this was swallowed through the stricture (see Fig. 4).

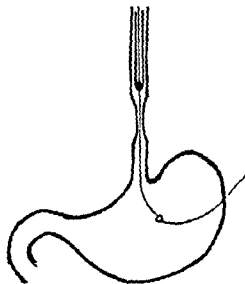


FIG. 4

No traction was ever exerted, and it was found that the tube did, in time, find its way through to the stomach. Some authorities suggest that bougies are drawn upwards *via* the gastrostomy, through the stricture, and out through the mouth. Grey Turner has always laid great emphasis on patience and gentleness in handling such cases, urging that patients "swallow" their bougies, and it is again stressed that, in handling this case, no traction was ever used, and yet the bougies, given time, were pushed through the stricture by peristalsis, inch by inch at first, and finally rapidly and completely. Encouraged by this, this procedure was repeated twice daily, with ever-increasing sizes of bougie (rubber catheter), up to size 10. It took two months to achieve this.

At this stage, the thread and rubber catheter technique was abandoned in favour of simple bougies, which were swallowed by the patient twice daily.

J. V. Clark

The bougies used were made up by turning a brass bull nose with central spigot over which a rubber tube was slipped. The tube was then filled with mercury.

The gastrostomy tube was now abandoned, and, five months later, the patient was sent home, using size 14 regularly. By then, the patient was two stone heavier than at the time of his original admission into hospital.

An X-ray taken at this stage was reported on as follows :—

“Loaded bougie swallowed, and passed area without difficulty, and entered the stomach. Normal peristalsis observed in stricture site. Œsophagus is now almost normal.”

It is nearly two years since this patient left our hospital. Since returning to England, I have written to him, but have only recently had a reply. In his letter, he tells me he (foolishly) sought no further treatment, and has managed full diet without difficulty. His only concern now is to get a new bougie, as his old improvised one, having been used regularly, is now worn out !

SOCIETIES' PROCEEDINGS

ROYAL SOCIETY OF MEDICINE—SECTION OF OTOTOLOGY

November 7th, 1947

President DONALD WATSON, F R C S

Progress in the Treatment of Mastoid Infection and some of its Complications

PRESIDENT'S ADDRESS

By DONALD WATSON, F R C S

THE discovery of antibiotics has simplified and, with the advent of others, will increasingly simplify the treatment of acute conditions of surgery

In his Presidential Address two years ago Graham Brown (1945) said

" I believe the opportunities for mastoid surgery are gradually decreasing in proportion as the prophylactic measures against the incidence and spread of aural disease increase. Indeed, the time may not be far distant when intracranial complications of otitic origin will be considered rare phenomena "

My introduction to mastoid surgery was in 1920 in Edinburgh, where I worked for two years under Mr J S Fraser

His method of treating the acute mastoid cavity, after a most thorough removal of all infected bone, was to cleanse it with hot hydrogen peroxide and to pack the wound with iodoform gauze, leaving an adequate drain at the lower end after closure of the rest of the wound. The pack was removed on the third day, the wound was repacked and continued to discharge more or less for three to four weeks before healing took place. This ideal was not always attained. Often the wound broke down, when eusol syringing was carried out twice daily. An infected, broken down wound meant prolonged treatment, sometimes of many months' duration.

Going to Bradford in 1922, for four or five years I tried other methods then practised, such as the blood clot method—closure without drainage. This was very unsatisfactory, as the wound usually broke down. Then there was the method of leaving the wound almost entirely open, packing it, and allowing it to heal by granulation tissue from the bottom. This was a tedious method, but it certainly obliterated the cavity, and there were no recurrences. The subsequent depression over the mastoid is unsightly. Nevertheless, it is a method practised even to day in certain clinics.

Next came the use of various antiseptics with packing. Of these T C P first produced about 1922, was the most successful in my hands.

It was in 1928 that I discarded bipp and reverted to the Carrel-Dakin method of flushing the wound with eusol and drainage by rubber tubes. This method

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was employed almost exclusively until early in 1933. It was a safe method—took time to do the dressings, but obliterated the cavity. T.C.P. was used as a final lotion for dressing the wound.

In February of 1933 a severe influenza epidemic occurred and, at its height, no less than 53 cases of acute mastoiditis were in hospital at the same time. Most of these were severely infected, some had complications, and the labour of dressing them was a tremendous strain on our nursing resources.

I decided to go back to using bipp in the liquid form, with a small gauze drain at the lower end of the wound. The bipp in the paste form used a few years previously was too solid and I am sure it caused the recurrences. The liquid bipp plus drainage for two or three days greatly lessened the number of recurrences.

This bipp method, published by Mr. Herbert Tilley (1919), Holt Diggle and Gilhespy (1921), supported by Macnab of Johannesburg and others, was the most successful in my hands and also in the hands of other surgeons, and I have used it until 1944. The great majority of cases were discharged, with the wound healed in a fortnight. Packing the wound was dispensed with.

Secondary Suture. When there was osteomyelitis of the squamous temporal and of the occipital bone, it might be necessary to enlarge the mastoid wound by one or more radial incisions, backwards or upwards and backwards.

In such wounds and also in widespread and severely infected cases, a bipp pack left undisturbed for five or six days enabled one to do the secondary suture, which was so important. The wound must be closed in five to six days, otherwise, owing to shrinkage and curling of the flaps, it may be impossible.

Even with bipp sometimes a child's wound would not heal. Occasionally I gave these tardy cases a weekly dose of tuberculin in a glass of milk, an hour or so before breakfast. This has a most beneficial effect on these slowly healing wounds.

To-day the universal practice is to dust the mastoid wound lightly with penicillin and sulphathiazole powder and close it, except perhaps for a small gauze drain at the lower end left *in situ* for a couple of days. Most cases are discharged healed by the twelfth day with a dry ear. In severe infections, the giving of sulphonamides and penicillin is an added safeguard. This modern treatment has shortened the stay in hospital tremendously. Whether the aditus remains open and recurrences are to be expected more frequently, I am doubtful, but the great saving of time and worry outweighs this possibility. Even secondary suture in mastoid surgery will, I believe, also become a relic of the past.

Lateral sinus thrombosis. In these days of antibiotics and chemotherapy cases without cerebral complications should all survive.

With regard to ligation of the jugular vein: years ago, Mr. Ballance said there were occasions demanding ligation, and there were occasions where the local condition in the sinus could be dealt with efficiently without ligation. A more rational opinion one could not have on this problem. I was always prepared to ligate the vein if occasion arose, as I am firmly convinced of the efficacy of this procedure. Even with the aid of chemotherapy I should not hesitate to ligate the vein if the case had symptoms of pyæmia with infarction of the lung. Otherwise treatment of the local condition of the sinus is all that is necessary.

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To obtain the best results in lateral sinus cases, surgeons have had to do the dressings themselves for many days, but we got good results, even as high as 80 per cent recoveries in cases without cerebral complications

The accompanying septicæmia is the danger in sinus thrombosis. Antitoxic sera of all kinds have been tried. The best, I believe, was the scarlatinal antitoxin. Quinine was also used. It did one good thing. Frequently a fixation abscess occurred at the site of the injection. One was always pleased to see this. These cases entail long and tedious treatment and careful observation.

I have opened eleven abscesses including an infected knee joint and an ankle-joint in one boy, and he recovered with no disability except a stiff knee.

Lateral sinus thrombosis cases have given us many interesting struggles. Pus in the internal jugular vein was not a rare occurrence.

With the continuation of rigors or swinging temperature—a common occurrence—one has frequently traced the lateral sinus back to the torcular Herophili before effecting a cure, this process requiring three or more operations. Mr J S Fraser always packed the interior of the open sinus with iodoform wool, but I understand some surgeons did not believe in this rational procedure.

I have had only one case of cavernous sinus thrombosis as a complication—a man aged 28. I am informed that after his recovery he lived for a further six months and died at home with symptoms of brain abscess.

Perhaps my most interesting case was one in which an abscess developed at the root of the neck, just between the clavicles. I waited before opening and packing this one. On removing the dressing two days later I was alarmed when I looked inside, as there was no reaction in the walls of the cavity and everything seemed to be pulsating. I repacked that cavity with bipp and left it. *This child of 5 had an interesting reflex. Her lateral sinus had been opened almost to the torcular, and each day as I dressed her and touched the sinus wall she complained of pain on her nose—a reflex through the meningeal branches of the Vth nerve. She eventually recovered after having been on sulphathiazole continually for six weeks and having taken nearly 800 grammes.*

The actual percentage of cure, in cases where lateral sinus thrombosis arises, is high, but in the future it may be expected with the early use of chemotherapy that this complication will be progressively more rare. Apart from the Schwartze or other original operation there should be next to no need of any added major operative procedure and, consequently, a greatly lessened stay in hospital.

Meningitis is a fairly common complication of mastoiditis. Its early diagnosis is important.

Progress in the treatment of meningitis is so intimately dependent upon early diagnosis that I shall now discuss the sign upon which early diagnosis depends. The picture of meningitis I need not detail.

The most important sign in my opinion is early stiffness of the neck. You know how easily anyone and especially a young child, is able to flex the neck, put the chin on the chest and then move the chin laterally—i.e. rotation. The slightest restriction of extreme flexion and rotation is demonstrable by comparison with a normal patient and is the most valuable sign.

In a paper on meningitis, T B Layton (1935) laid great stress on this early

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stiffness of the neck. In spite of views to the contrary, I think this sign is always present if it is looked for in the manner which he described.

On one occasion I was called to a fever hospital to see a nurse. Three days previously she had a pimple just inside her nose, and as she was going to a dance that evening she pricked it. When I saw her, she was lying on her back, her head propped up by pillows, with violent headache and a high temperature. I took the pillows away and tested her neck. She could bend her neck easily up to the angle of rest on the pillows, but beyond that it was rigid. Diagnosis—meningitis. The doctor in charge said "nonsense, she can flex her head easily", and so she could up to the angle of rest. We did a lumbar puncture: the cerebrospinal fluid was very cloudy—she died in twenty-four hours. I mention this as one of the pitfalls in testing the neck for stiffness.

Twenty-five years ago, meningitis was a deadly complication. About 80 per cent. or more of the cases died, and although one's luck varied, the results were poor, or at any rate mixed, until the sulphonamides arrived. In 1929 I had three cases in succession who survived but this was just a flash in the pan.

My personal results improved after using the technique of T.B. Layton (1935), that is early operation to remove the focus of infection, with free removal of the tegmen, keeping the wound open by means of stitching the flaps back, and flushing regularly with saline. As a modification, later I used hypertonic saline packs. Lumbar punctures were done daily, and sometimes twice daily. My figures improved to over 30 per cent. recovery with these methods. I also tried injecting the theca with various antiseptics, solganol and others, but it did not appear to affect the recovery rate.

In the early thirties, Neuman evolved an operation with a very wide removal of the tegmen tympani as far forward as the eustachian tube, elevation of the dura and exposure of the upper surface of the petrous, then wide removal of the tegmen antri. Ruttin (1934) using this method claims a 50 per cent. recovery. These were the best results published up to 1934. Sulphonamides increased

TABLE I.

BENIGN FORMS OF OTOGENIC MENINGITIS (MYGIND, 1922)

Based upon the observation of 210 patients with meningitis of all forms, caused directly or indirectly by acute or chronic middle-ear suppuration, over the past seventeen years.

	Total.	Recoveries.	Percentage.
Meningitis (uncomplicated)	115	38	33.0
" plus sinusphlebitis	42	16	38.1
" plus brain abscess*	21	4	19.0
" plus subdural abscess	2	0	0.0
" plus subdural abscess plus brain abscess	2	0	0.0
Meningitis plus sinusphlebitis plus brain abscess	15	0	0.0
Meningitis plus sinusphlebitis plus subdural abscess	6	0	0.0
Meningitis plus sinusphlebitis plus brain abscess*	7	1	14.3
	210	59	

* Including encephalitis.

= 28% recovery.

These are the best, and by far the most complete results published in the *Journal of Laryngology and Otology* up to 1922. 28 per cent. over-all recovery.

My personal results for seven years after 1922 show a 19.6 per cent. recovery. This is just less than 20 per cent. against Mygind's 28 per cent. all cases.

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the recovery rate greatly, up to 50 per cent. and penicillin has improved it still further, until to-day the recovery rate is over 80 per cent. in uncomplicated cases.

TABLE II

TWENTY-ONE CASES OF OTOGENIC MENINGITIS SHOWING THE TIME RELATION OF OPERATION ON THE EAR TO THE COURSE OF THE ILLNESS, THE PREVIOUS HISTORY, THE RESULT AND THE CAUSE OF DEATH (CAIRNS, 1946)

Operation	No of Previous cases otitis		Recovered	Died	Cause of death
Mastoidectomy before meningitis	3	2	2	1	Abscess
Mastoidectomy at height of meningitis	3	1 (2)	2	1	Heart failure and inhalation pneumonia
Myringotomy at height of meningitis	1	1	1	0	
Mastoidectomy during convalescence	2	1	2	0	
No operation	13	4	9	4	
					= 77·7 per cent recovery, 7 out of 9
					(i) delay in chemotherapy
					(ii) and (iii) abscess
					(iv) acute cerebral oedema
					= 69 per cent recovery, 9 out of 13
	22		16	6	

= 72·7 per cent recovery

One patient (Case II) had two operations

Previous otitis = a previous history of infection of the ear

This paper was the result of experimental research by Professor Cairns and his team. As an experiment it is a remarkable tribute to the power of present day chemotherapy. I should like to draw attention to one or two facts in this table, but not in a critical vein.

It is interesting to note that in those cases (a) Operated on (9 in all) only 2 died—77·7 per cent recovery, (b) not operated on (13 in all) 4 died—69 per cent recovery.

This is in spite of the fact that in 6 of (a) no pre-operative chemotherapy had been carried out.

have saved the two brain abscess cases, and even the acute cerebral oedema.

I have no knowledge, but I can quite appreciate the diffidence of aural surgeons advising operative interference during this experiment—evidently they were not consulted in some of the cases.

In this experiment it will be observed that brain abscess even in the hands of a neurosurgeon, caused most of the deaths—3 out of 6.

This table emphasizes the value of chemotherapy, which was given in all cases before operation for about twelve hours, and continued after operation until the temperature had remained normal for two days. The recovery rate of 84·6 per cent, compared with my earlier records up to 1927 of 20 per cent recovery rate needs no comment. All the cases except one (71·46 R P) had mass mastoidectomy performed.

Labyrinthitis The subdivisions of this disease usually given in a textbook are somewhat bewildering.

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TABLE III

A SERIES OF 13 CASES OF MASTOIDITIS WITH MENINGITIS FROM 1944 TO 1947. TWO DEATHS IN THIRTEEN—84.6 PER CENT RECOVERY. DONALD WATSON, BRADFORD

Date	Name	C S Fluid	Organism	Treatment.	Findings
13 1 44	J C B.	Cells + (5)	Streptococcal	Sulph	Mastoiditis and meningitis
10 4 44	H B	Cells + (6)	Small Coagulum	Sulph	Mastoiditis and brain abscess
19 5 44	L J	(1)	No growth	Sulph	"
9 1 45	G O	Cells + + (2)	No growth	Sulph	"
18 4 45	A P	Cells + (3)	Pneumococci	Sulph and pen	"
18 9 45	V.N	Cells + + (5)	No growth	Sulph. and Pen intrathecal	Mastoiditis and meningitis
29 12 45	M B	Turbid (3)	Streptococcal	Sulph and pen	Mastoiditis and meningitis
7 1 46	R P	Turbid cells + (3)	Streptococcal	Sulph and pen intrathecal	Meningitis
6 2 46	J B	Cells + (3)	No growth	Sulph and pen	Mastoiditis and meningitis, lateral sinus thrombosis ligature of vein
12 2 46	G B	Cells + + (1)	No growth	Sulph and pen	Mastoiditis and meningitis (died 14th)
4 9 46	W.S	Turbid (2)	No growth	Pen	Mastoiditis and meningitis (died 11th), oedema of lungs, duodenal case
23 12 46	R C	Cells + (8)	No growth	Pen	Mastoiditis and meningitis
19 8 47	M F.	Clear (2)	No growth	Sulph and pen	Mastoiditis and meningitis

The figures in brackets indicate the number of lumbar punctures performed
Sulphathiazole was used in every case

The circumscribed type with the fistula sign is definite, as is the diffuse purulent type, but the serous types are not so definite and clinically do not matter—if left alone they recover. Lastly, there is the latent diffuse type—probably with a dead labyrinth.

As a complication of acute mastoiditis, I have seen only one case of diffuse purulent labyrinthitis with its severe symptoms, a small boy of 6. He had an extremely severe mastoid infection with labyrinthitis, lateral sinus thrombosis and meningitis. He died twenty-four hours after admission. I had performed a Schwartze operation in the meantime, but his was a fulminating generalized infection. At the post-mortem the saccus endolymphaticus was a bag of pus—the only case I have seen. I am aware that, through the years, recoveries of a few cases of acute diffuse labyrinthitis have been reported in the journals. This rare complication of mastoiditis—primary acute diffuse purulent labyrinthitis—is almost certainly a blood-borne infection as is primary pan-opthalmitis.

I shall return to serous labyrinthitis in acute mastoiditis. In the following remarks, I shall discuss two problems:

(1) The inadvisability of testing the labyrinth by caloric and rotation tests in cases of mastoiditis with labyrinthine symptoms, either acute or chronic.

(2) The relationship of labyrinthitis and meningitis. This problem appears to me to be more readily studied and understood in acute than in chronic mastoiditis.

The accepted views on labyrinthitis were clearly expressed by E. D. D. Davis (1928). He stated:

“The records of cases of meningitis which followed chronic suppuration reported by Logan-Turner, Fraser, Jenkins and myself have shown that the symptoms and signs of labyrinthitis were present in a very large proportion. Vertigo, tinnitus, nystagmus and a marked degree of deafness accompanied by headache and fever *with an increase of cells in the cerebrospinal fluid* call for a translabyrinthine drainage of the meninges without hesitation. There are

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certain signs of the spread of infection which forecast coming events *Labyrinthitis is such a sign, and it requires careful investigation and prompt action as soon as it becomes apparent* "

Tweedie (1934), who knew as much as anyone of his generation about the physiology of the labyrinth, supports the above view. In a paper published in 1934 he stated that in inflammatory lesions of the labyrinth—as in inflammation of any other organ—the normal responses to stimuli were upset, and all sorts of contradictory results obtained. In his seven point summary of the test, in point six he stated " that an attempt should still be made to assess the inference of spontaneous nystagmus in cases of acute otitis media " Previously he states that it is in these acute cases where we require assistance in assessing the amount of labyrinthitis that we shrink from applying the tests, and that generally we restrict the use of the labyrinth tests to chronic inflammatory cases of otitis media to determine whether or not the labyrinth is still functional.

I am of opinion that the above views are entirely wrong, and if carried into practice increase the danger to life in the treatment of labyrinthitis whether associated with acute or chronic mastoiditis. During the four years 1922-25 I carried out the usual cold caloric and rotation tests (Cold water (65° F, 17° C) and the Bárány chair) in all cases of chronic mastoiditis. I operated on three cases with signs of labyrinthitis, and all three cases died of meningitis. During these years my colleague had no deaths. On careful investigation I found that the difference between his technique and mine was that he did not test any cases of labyrinthitis, whereas I did both caloric and rotation tests. I think it was the late Mr. Albert Gray who said that the labyrinthine capsule had great powers of defence and was capable of looking after itself in the presence of aural infection. As a result of these practical and theoretical considerations, I decided to stop testing the labyrinthine function, and wherever symptoms suggestive of labyrinthine upset occurred, to put the patient at rest, sand-bagging the head. During the twenty-one years that have passed since then, though I have had a number of cases of circumscribed labyrinthitis with the fistula sign, I have had no deaths from labyrinthitis in chronic mastoid disease.

It is my emphatic opinion that cases of mastoid disease in which labyrinthitis is suspected should be left at rest and that this complication will disappear in about three weeks. Several reasons may be put forward for regarding the widespread practice of testing the functions of the labyrinth in those cases as both useless and dangerous.

The labyrinth is endowed by nature with strong defensive powers against infection. It is separated from the middle ear by a thin layer of bone—the stapes in the oval window, and the round window—and has to resist infection from a vast number of cases of middle ear suppuration and mastoiditis annually. I have diagnosed about 6 cases of petrositis but none complicated by labyrinthitis, cases of Gradenigo's syndrome without labyrinthitis, cases of herpes of the geniculate ganglion, all of which had vestibular upset, but all recovered. In chronic mastoiditis, I have had a number of cases of circumscribed labyrinthitis with the fistula sign. Since 1926 not one has developed diffuse labyrinthitis. Surely all these points are evidence of its great resistance to infection.

The rarity of severe labyrinthine infection compared to the vast number of

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Packing the wound with gauze led to a surface slough and secondary sepsis and must be avoided, a drainage tube was far better.

When meningitis was threatened the wound was left open but not packed. Rigidity or slight stiffness of the neck was a too late sign. Very few cases of meningitis with rigidity of the neck recovered. The rigidity was caused by a collection of purulent fluid in the basal cisterna and around the crura cerebri. The examination of the cerebrospinal fluid was the only way to make an early diagnosis. Cases of meningitis arising from a blood-borne infection died very rapidly as in the case the President had mentioned.

In 1922 it was agreed that an operation on the labyrinth for labyrinthitis should not be done before the labyrinthitis was localized. A threatened or established meningitis demanded operation.

Lund of Copenhagen and others relied on the examination of the cerebrospinal fluid. If the cell count increased it was an indication for operation. A large number of labyrinth operations had been done because of the fear of meningitis.

Children and young adults were more susceptible to meningitis than old people. The unexplained severe headache with a rise of temperature and pulse, the cellular mastoid pouring serous fluid with deep-seated pus in the cells behind the facial nerve, the mastoid following scarlet fever and measles all pointed to the possibility of meningitis. Treatment by sulphonamides and penicillin had improved the prognosis of meningitis.

MR. T. M. BOYLE made a plea for the use of heparin in a small number of cases of lateral sinus thrombosis. He cited the case of a girl aged 15 who had the lateral sinus drained and continued to have rigors for about a week afterwards. She was having large doses of penicillin and sulphonamides. Then a general surgeon put her on heparin, and from that day she made a rapid recovery. He would not say that all cases should have heparin, but those cases not responding to treatment. In another small group of cases of mastoiditis there were resistant organisms. *B. pyocyaneus* being one of the offenders, and here he thought phenoxetol, a proprietary preparation, was of great value. He recalled a case which had had the mastoid opened about ten years ago, and later developed a recurrence: an attack of mastoiditis with a green discharge. It dried up but recurred on several occasions. The mastoid was opened and the drainage tube inserted and phenoxetol applied in the cavity. Within three days the discharge from the external meatus was sterile, and within six days the middle ear was dry.

MR. W. H. BRADBEER said, with regard to latent labyrinthitis, that two patients in whom he suspected that the labyrinth was dead both developed meningitis following operation. One was a mild case and recovered. In the other a very severe meningitis developed, and eventually a cerebellar abscess, but this case also recovered after opening the labyrinth and draining the abscess. If one was doing a radical mastoid operation with a dead labyrinth he had come to the conclusion that one should open the labyrinth as well, but after what the President had told them he was uncertain on that point. He thought they would still see chronic ears, and one came across children in school clinics with chronic otorrhœa and with an attic perforation.

MR. F. MCGUCKIN said he believed a cerebral abscess might arise at any stage of an otitis because of the possibility that a localized infection in a

perivascular space might act as a preformed path. On the question of labyrinthitis he agreed almost unreservedly with the President's plea, in so far as the complication was related to acute otitis.

MR F W WATKYN-THOMAS said that a danger in using heparin was that the clotting time was altered for a considerable time afterwards, which might give trouble should further surgery be needed. The justification for the use of heparin in sinus thrombosis would be to make sure that the antibiotics came into contact with the organism, an organism in the clot was safe from anything in the way of penicillin or sulphonamide treatment.

On the question of translabyrinthine drainage, since the use of sulphonamides he had only seen two cases of meningitis which were undoubtedly due to labyrinthine infection—at any rate they had certainly followed upon a labyrinthitis. In these two cases he refrained from translabyrinthine drainage because he felt that, if the cerebrospinal fluid was released, it would be more difficult to keep up the requisite sulphonamide concentration. Both patients recovered. The translabyrinthine operation had been the greatest advance in treatment in its day, but now it would rarely, if ever, be necessary.

MR OGILVY REID referred to the rarity of such a complication as facial paralysis in acute mastoiditis or acute otitis media. He had in mind one or two recent cases which illustrated the difficulties which chemotherapy had introduced in the treatment of mastoid conditions and the way in which the picture was obscured. One case had had massive doses of penicillin and was apparently doing very well when a facial paralysis developed. He operated on the case and though he found no lesion relating to the facial nerve yet the facial paralysis began to recover after the operation.

MR R R SIMPSON asked what would be the President's attitude in the case of the labyrinth in the presence of otitis media with fistula signs? He himself did a radical mastoidectomy in such a case without interfering with the labyrinth at all, and so far he had never regretted it.

MR J H ORRY felt sure that an adequate dosage was the essential in the use of the sulphonamides or penicillin, but it was equally important to tighten up the criteria of cure. These patients should not be let out of hospital unless the surgeon was satisfied, not only that the ear was dry, but that the tympanic membrane had returned to normal and the hearing had been restored.

MR L GRAHAM BROWN said that as a senior he felt that he had had a considerable experience of these cases during the past quarter of a century. The young practitioner only saw the question from his own recent experience and naturally was a little perturbed as to what the treatment really ought to be. The time had now come when chemotherapy had taken a large part in the treatment of these affections. He wished to say with regard to chemotherapy that he used it only as an adjunct to surgery. They were all aware that its application in the early stages of acute inflammation of the middle ear might be successful in relieving the condition, but also they knew the dangerous effects which might be brought about if it was used at a time when pus was formed in the middle ear or the mastoid bone or in the further complications of the disease. They were aware of the fatalities which occurred. Perhaps the mastoid operation would be followed by almost complete resolution, and then, some weeks afterwards, a brain abscess or meningitis occurred and the patient often died.

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He had not operated on a case of labyrinthitis for many years—perhaps fifteen years. Cases in which there were signs of labyrinthine irritation in chronic disease of the mastoid, which flared up, he had dealt with by performing a radical mastoid at the opportune time, providing there was no evidence of the disease spreading to the meninges. Such cases had invariably got well. In view of the statements that these cases were rapidly diminishing, it was strange that Mr. Simson Hall should have seen recently several cases of lateral sinus thrombosis. He himself had not seen one for two or three years, but, curiously enough, he had three cases of meningitis, and these were cases of chronic mastoiditis, all of which, after removal of the focus in the mastoid—going no further, and putting them on chemotherapy—had recovered. The most important thing was to learn how and when to use chemotherapy.

MR. TERENCE CAWTHORNE said that the high light of the President's Address was that he had had the courage years ago not to treat the labyrinth surgically in the early stages of an infection. Most of them had come to realize, now that they had recourse to chemotherapy and biotherapy, that early surgical treatment was wrong. He agreed with Mr. Layton who had suggested that chemotherapy should precede surgery even in chronic conditions where there was an acute flare-up.

Mr. H. S. SHARP said that in acute middle-ear disease he never gave chemotherapy unless he had first obtained drainage from the ear. Such cases were followed up very carefully by means of X-rays, and in adults, in addition to X-rays, by tests for deafness.

THE PRESIDENT (Mr. Watson), in a brief reply, said that if there was any surgery to be done it must be done and done early, but on cases that had been on penicillin or sulphathiazole for three or four weeks there was no harm in operating if there was any doubt. Mr. Boyle had spoken of cases in which sulphathiazole and penicillin were given at the same time. That was an interesting point and one for discussion in the Section. He had seen two cases of meningitis in patients who had had too large doses of penicillin and sulphathiazole. The temperatures did not drop and he could not understand it. In one of the cases he stopped penicillin and the temperature dropped immediately, nothing else happened. In the other case he stopped sulphathiazole, with the same result. Some of these patients were "killed by kindness". Too much in the way of antibiotics could be given. Whether heparin counteracted the effects he could not say.

There had been a great deal of confusion about the chronic mastoid. People talked about labyrinthitis after they had been, he was sure, testing the cases. He himself would not have anything to do with testing, and if anyone talked about labyrinthitis after having done caloric, rotation or electrical testing he thought it a sequel. The plea he would put forward was to stop physiological tests. He drew an analogy from the heart. There was a tolerance test for the heart by which one observed the heart's function. This was carried out on a normal or near-normal heart. Would a clinician test a heart with valvular disease by means of these tolerance tests? Would he test a patient with a temperature of 102° F. whom he thought was developing endocarditis by asking him to run upstairs and down again? Of course he would not, but it was something like this that they had been doing in otology.

ABSTRACTS

EAR

Nonvibratory Tinnitus factors underlying Subaudible and Audible Irritations

E P FOWLER, M D (New York) *Arch Otolaryng*, 1948, *lvii*, 29-36

An instructive summary of the ætiology, investigation and management of Nonvibratory Tinnitus

R B LUMSDEN

Ménière's Disease TERENCE CAWTHORNE (London) *Ann Otol, Rhin and Laryng*, 1947, *lvi*, 18

Although paroxysmal vertigo has been known and described since the early days of the Christian era, it is only within recent years that there has been a clear conception of the pathology. The essential mechanism of the disorder is an obstructive distention of the endolymphatic system, the fluid of which is derived from the stria vascularis and passes through the wall of the pars intermedia of the sacculus endolymphaticus into the loose perisaccal connective tissue, where it is diluted by osmosis and reabsorbed into the blood stream. The histological changes which have been observed in the perisaccal connective tissue would be sufficient to interfere with this delicate mechanism, and as a result the endolymphatic system could not adjust itself to any sudden variation of tension.

It is unlikely that eustachian insufficiency or other middle ear lesion plays much part in Ménière's disease, nor is there any real evidence of a traumatic factor. Variations in fluid metabolism may however, play an important part.

In the series of 424 cases reviewed in this paper there were rather more male than female, and 75 per cent occurred in the ages between 30 and 60. The main characteristic features were paroxysmal vertigo, with nausea vomiting, tinnitus and perceptive deafness always more marked on one side than the other, and absence of any central nervous system signs. There is a tendency to bouts of paroxysmal attacks followed by periods of freedom. The attacks occur without apparent cause. Rather less than half the patients had some warning of an impending attack, alteration of character or intensity of tinnitus, increase in deafness, or fullness and discomfort in the ears being the commonest aura.

During the attacks which varied greatly in intensity and duration there was generally subjective sensation of movement, either of the patient or of surrounding objects. Nausea and vomiting were usual and deafness and tinnitus rarely absent.

Deafness was subject to variation especially early in the disease and such hearing as was retained lost much of its value owing to the marked discomfort due to distortion of loud sounds.

Spontaneous nystagmus was observed only during the acute attacks of vertigo, or immediately afterwards, but the caloric test described by Fitzgerald

Nose

then a combined middle-ear and inner-ear deafness must already be present. This, with other findings, strengthens the view that the inner-ear lesion plays an important role in otosclerosis, and sets in much earlier than is hitherto believed. It remains for a long time clinically latent, and hidden by the dominating symptoms of conduction impairment. The slowly progressing atrophy.

DEREK BROWN KELLY.

NOSE

Plastic Repair of the obstructing Nasal Septum SAMUEL FOMON, M.D. (New York); J. G. GILBERT, M.D. (New York); A. G. SILVER, M.D. (New York); V. R. SYRACUSE, M.D. (New York). *Arch. Otolaryng*, 1948, xlvii, 7-20.

Generally speaking, a better result will be obtained if the rhinoplasty and the septal correction are done in separate operative stages three or more weeks apart. Inasmuch as the final outcome of the operation depends in a measure on the healing qualities of the tissues, the smaller amount of trauma inflicted by dividing the stages speaks for less reparative reaction and a better anatomic and physiologic result.

As to the order of sequence, the old teaching advocated that the rhinoplasty precede the submucous resection on the grounds that the septum supported the nose and that if the submucous resection were done first a subsequent removal of a hump might open into the resected area and result in saddling. New concepts of the structural anatomy of the septum have proved this assumption fallacious, and to-day the submucous resection is done first since it permits an easier osteotomy and a more symmetric alignment of the pyramid. But there are occasions when it is impossible to restore breathing without simultaneously correcting the external deformity and the deviated septum. For instance, if there is a long nose with a caudal displacement of the septum, resection of the lower part of the septum to shorten the nose automatically eliminates the deflection. And in cases in which the deviated septum is a part of an S-shaped or deflected nasal pyramid, it would be impossible to place the septum in the sagittal plane without an accompanying rhinoplasty.

R. B. LUMSDEN

Nasal hæmorrhage: studies of Ascorbic Acid, Prothrombin and Vitamin K H. NEIVERT, M.D. (New York); RECHA ENGELBERG, PH.D. (New York); L. A. PIRK, PH.D. (Nutley, N.J.). *Arch. Otolaryng*, 1948, xlvii, 37-45.

The extremely high incidence of ascorbic acid and prothrombin deficiency in a series of 104 consecutive cases of epistaxis and the gratifying clinical results attending the administration of ascorbic acid and/or a vitamin K-like substance in some of these cases suggest that vitamins C and K have a definite place in the management of nasal hæmorrhage.

R. B. LUMSDEN.

Abstracts

Subdural Empyema secondary to Frontal Sinusitis. FRANK M. ANDERSON (Los Angeles). *Ann. Otol., Rhin. and Laryng.*, 1947, lvi, 5.

Subdural empyema is a not uncommon complication of frontal sinusitis, but is more commonly discovered at autopsy than during life. The mechanism of origin varies, but is most commonly due to spreading thrombosis of the perforating veins. Direct spread by perforation of the dura mater must be uncommon.

The complication is commoner in acute frontal sinusitis than in the chronic form. As a rule the course of the disease is short, survival being a few days only if the condition is not recognized and treated. The signs of subdural infection follow almost imperceptibly on those of acute sinusitis. Irritability, frontal or general headache with malaise and fever, are followed by lethargy and gradually increasing stupor within a few hours or days. Later lateralizing and localizing signs become evident, hemiparesis (generally contra-lateral) flaccid or spastic in type, and Jacksonian epilepsy occur and the picture of the untreated case passes on to that of established meningitis.

The differential diagnosis is from cerebral abscess, in which the symptoms are milder and slower in development; from thrombosis of the superior longitudinal sinus in which the symptoms tend to be bilateral the temperature of "septic" type and meningeal symptoms less; from meningitis in which the onset is generally more gradual and the cerebrospinal fluid has a higher cell count; and from extradural abscess in which the patient is much less critically ill.

There is only one treatment—prompt and adequate drainage. The author recommends placing burr holes strategically round the affected area to facilitate irrigation and the instillation of penicillin. The record of three cases is given, two of which died.

GILROY GLASS.

The Histologic effect of repeated application of certain Nose Drops to the Nasal Mucous Membrane of Rabbits. ROBERT E. RYAN (Rochester, Minn.). *Ann. Otol., Rhin. and Laryng.*, 1947, lvi, 46.

The effect of the prolonged use of certain commercial nose drops is to produce a condition of chronic nasal congestion in the human subject. The object of this investigation is to reproduce the same conditions experimentally and observe the histologic changes produced. Two commercial preparations widely used in the U.S.A. were chosen.

The first preparation contained dl-desoxyephedrine hydrochlor 0.125 per cent. Sodium sulphathiazole 1.25 per cent. and Sodium sulphadiazine 1.25 per cent. in a stabilized aqueous base. Preparation two contained 2-naphthylmethylimidazoline Hydrochloride 1 per cent. in an isotonic aqueous solution. This is an organic vaso-constrictor having a similar but more prolonged action to epinephrine.

With the first preparation ciliae were absent after the fifth day. Dilatation of vessels was observed on the third day and persisted for some weeks. Scattered inflammatory cells were observed early, increased in number till the fourth week then gradually disappeared.

Nose

Epithelial damage occurred by the fifth day, passing through a stage of œdema to degeneration and final replacement by stratified epithelium. A mucocellular exudate appeared in the first week and persisted till the ninth week.

With the second preparation the disappearance of ciliae was the first change noted and did not occur till the eighth day. Dilatation of vessels occurred early. After forty days the vessels were constricted and showed some sclerosis.

Epithelial damage commenced after a week and progressed till the fifth week when the degenerative changes were so marked that the mucosa bore little resemblance to normal nasal mucosa. By the tenth week the surface epithelium had changed completely from ciliated to stratified type.

As the clinical changes in the nasal mucosa of rabbits are not dissimilar to those observed in the human, it is reasonable to assume that the histologic changes may be parallel.

GILROY GLASS

The use of Streptomycin in the treatment of Diffuse External Otitis
B H SENTURIA and R H BROH-KAHN *Ann Otol Rhin and Laryng*,
1947, lvi, 81

A type of diffuse otitis externa believed due to pseudomonas organisms is described (pseudomonas are defined as gramme negative motile rods growing well on ordinary nutrient media and producing a characteristic water soluble, chloroform soluble greenish pigment).

Treatment of this type of otitis externa with streptomycin in strengths of 250 microgrammes and 10 mgr per gramme of ointment base was no more effective than use of the ointment base alone. Use in a strength of 50 mgr per gramme gave promising and beneficial results. In a control with simple cleansing and drying of the ear canal no beneficial results were obtained.

GILROY GLASS

The Classification and treatment of patients with Chronic Nasal Symptoms
EDWARD D KING (Hollywood) *Ann Otol Rhin and Laryng* 1947
lvi, 70

Sinus disease is less frequent than might be thought from the number of patients who complain of headache, nasal obstruction and dripping in the throat. These symptoms are generally and frequently wrongly attributed to sinus infection, whereas in many cases they are manifestations of allergy.

An accurate history is invaluable. Allergic conditions may follow an acute respiratory infection, but more frequently the onset is insidious. Patients with a sinus infection can generally state the onset and will frequently give a history of repeated attacks generally unilateral. Confirmatory evidence of allergy may be found in either the personal or the family history.

Smears from either nose or pharynx may be of the utmost value in arriving at a diagnosis. Pus cells will be found in sinusitis, eosinophils in allergy. Radiological examination should be routine. Clouding of a sinus does not necessarily mean infection. The conclusive proof is irrigation.

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If a diagnosis of allergy is made, the rhinologist may have to consider operative procedures. While proper aeration and breathing are essential, and obviously such gross obstructions as polypi should be removed, every means of treatment should be exhausted before advising the patient that a simple sub-mucous resection will solve the problem.

Too much reliance should not be placed on the skin tests. A survey of environment is essential, and the possibility of an allergy due to the use of nose drops must never be forgotten. The offending protein may only be found by a process of elimination.

GILROY GLASS.

Congenital Choanal Atresia. A new surgical approach. WILLIAM K. WRIGHT, G. E. SHAMBAUGH (Junior) and LOIS GREEN. *Ann. Otol., Rhin. and Laryng.*, 1947, lvi, 120.

A case is reported of unilateral choanal atresia in a girl aged 23. Features of the case were, protrusion of the lateral nasal wall medially at its posterior part, elevation of the floor of the nostril posteriorly to a level 1 cm. above the level of the opposite side, lateral deviation of the posterior part of the septum to the affected side, and a medial displacement of the lateral wall of the nasopharynx on the obstructed side, so that the eustachian tube orifice was almost in the mid-line.

Operation was conducted under local anæsthesia by blocking the second division of the trigeminal nerve in the posterior palatine canal. Access was through the usual Caldwell-Luc route. On opening into the nasal cavity through the inferior meatus a thick hard bony ledge was found projecting medially level with the posterior wall of the antrum. Just before this ridge made contact with the septum there was a shallow blind trough. When the posterior part of the septum was resected this ledge was found to project little farther than the lateral wall of the nasopharynx. It was not disturbed. A large rubber tube was passed through the anterior nares and the perforation made in the septum nasi to the nasopharynx. At the end of six months the patient's breathing was considered satisfactory.

GILROY GLASS.

TONSIL

The question of Prothrombinopenic Hæmorrhage from Post-Tonsillectomy use of chewing gum containing Acetylsalicylic Acid. G. S. LIVINGSTON, M.D. (Chicago); EDWARD R. NEARY, M.D. (NEWARK, N.J.). *Arch. Otolaryng.* 1948, xlvii, 1-6.

There is no indication that the routine post-tonsillectomy use of chewing gum containing acetylsalicylic acid may give rise to prothrombinopenic hæmorrhage or that such use of this gum has any adverse effect on blood prothrombin.

R. B. LUMSDEN.

Larynx

LARYNX

Laryngeal Polypoid Granuloma following Intratracheal Anæsthesia HAROLD S TUFT, and SIMON H RATNER (Pittsburgh) *Ann Otol, Rhin and Laryng*, 1947, lvi, 187

and

Granuloma of the Larynx A late complication of Endotracheal Anæsthesia LEWIS W BARTON (Albany) *Ann Otol, Rhin and Laryng*, 1947, lvi, 191

The above two papers are recording the occurrence of granuloma of the larynx following endotracheal anæsthesia. The recommendation is made that the larynx should be examined following any endotracheal anæsthetic, and if any abrasions are seen the patient should be placed on voice rest and receive appropriate treatment. Periodic examination should be carried out until the lesion has healed.

GILROY GLASS

MISCELLANEOUS

Chemical Meningitis following use of Tyrothricin A clinical and experimental study F J OTENASEK, M D (Baltimore), D FAIRMAN, M D (Baltimore) *Arch Otolaryng*, 1948, xlvii, 21-28

Two cases are reported in which chemical meningitis developed after a nasal sinus had been irrigated with a suspension of tyrothricin. The pathologic process was recreated in animal experiments, which are described. The profound changes noted are sufficient to raise a note of caution as to whether suspensions of tyrothricin should continue to be used for irrigating sinus cavities that are in close proximity to the subarachnoid spaces.

R B LUMSDEN

Some present day concepts of Headache JOSEPH H HERSH (New York) *Ann Otol, Rhin and Laryng*, 1947, lvi, 98

A review of 1,000 cases of headache revealed that the commonest causes in the order of frequency were vasomotor rhinitis, myositis cervicalis, mechanical nasal obstruction, paranasal sinusitis and neuro-psychiatric disorders. Less frequent causes were the vascular cephalgias, ophthalmic, pharyngeal, dental and cervical spinal disturbances.

Vasomotor rhinitis was diagnosed 552 times but could be designated as the prime cause of headaches in only 282 instances.

Myositis cervicalis was found 630 times and was regarded as the prime cause in 241 instances. In 470 patients, vasomotor rhinitis and myositis cervicalis were associated. Despite this frequency, the two may or may not be attributed to the same ætiological factor. Thus they may both be manifestations of a physical allergy, but an understanding of the mechanism of the reactions of the cervical muscles indicates that the myositis may be a secondary reflex from a headache caused by the vasomotor rhinitis.

The importance of recognizing the presence of an indurative myositis and the vicious cycle of headaches for which it may be responsible has been pointed out. It has been indicated that this cycle may be responsible for the continuation of a headache long after the prime cause has been corrected.

Abstracts

Mechanical nasal obstructions were discovered in 274 patients. In 90 they were believed to be primarily responsible for the headaches when combined with the normal vasomotor variations of the nasal mucosa.

Paranasal sinusitis did not prove to be as common a cause of headache as presumptive diagnosis would indicate. Its existence was substantiated in only 117 patients and the results of treatment were excellent.

Neuropsychiatric disorders were uncovered in 141 cases. Anxiety states and post-traumatic syndrome predominated. Treatment was unsatisfactory.

Ophthalmic disturbances were discovered in 35 cases and were primary causative factors in eleven patients.

Although the vascular cephalgias were presumptive diagnoses in fully 33 per cent. of the referred cases, confirmation was made in only 22 patients. Migraine is a definite symptom complex and the term should not be applied to any headache because it is associated with nausea and vomiting. (Author's summary.)

GILROY GLASS.

The treatment of certain specific types of Headache with Histamine.

FRENCH K. HANSEL (St. Louis), 1947, lvi, 152.

In 1939 and 1941 Horton described a headache syndrome to which they gave the name histamine cephalgia. Patients affected are mostly in the later decades of life. The headache is unilateral, commences suddenly and may even awake the patient at night. It seldom lasts more than an hour and terminates suddenly. There is associated lacrimation and congestion of the eye, rhinorrhœa or nasal congestion, and even swelling of the temporal vessels on the affected side. The distribution of the pain conforms to the ramifications of the external carotid artery and not the distribution of any nerve. One of the most characteristic features is the occurrence of the headache at night. Although most patients may have pain either by day or at night, in some there are only night attacks. Nausea, vomiting and visual disturbances do not occur.

The author has encountered 32 cases of this syndrome, and describes 5 typical cases in detail. He found that small doses of histamine varying from 0.1 of 1 : 1,000,000 solution to 0.5 c.c. 1 : 100,000 solution given every two to three days were effective in maintaining relief of symptoms. This was supplemented with sublingual administration of 1 to 2 drops of 1 : 10,000 solution once or twice daily. When the patient became entirely free from symptoms all treatment was discontinued, but it was found that a certain number of patients required maintenance dosage.

Of the 32 cases treated 29 had satisfactory results. (This dosage was rather less than the original recommendation of Horton.)

GILROY GLASS.

Acoustic Neuritis associated with Keratitis. DONALD K. LEWIS (Boston).

Ann. Otol., Rhin. and Laryng., 1947, lvi, 194.

Three cases are presented of a syndrome consisting of an VIIIth nerve neuritis in conjunction with interstitial keratitis. Both the keratitis and the

Miscellaneous

acoustic neuritis as well as the time relationship between them, differed considerably from that of congenital syphilis. The disease progressed over a period of six to seven months to a complete bilateral loss of function in the acoustic and the static labyrinths. The ætiology was not determined, and the possibility of a virus infection was not eliminated. Superior cervical sympathetic ganglionectomy, done early in the course of the disease on one patient, was without benefit. (Author's summary)

GILROY GLASS

Endocranial complications in chronic Meso-tympanic Otitis B KECHT (Linz)
Monatsschrift für Ohrenheilkunde, 1948, lxxxii, 49.

The statistical investigations of Bezold and others suggest that chronic meso-tympanic otitis is a comparatively benign disease, and seldom attended by intracranial complications. In his search of the literature, the author finds that from 1921 to 1942, only 15 such cases have been reported. To these he adds five of his own observation.

Three developed suppurative meningitis, the labyrinth being the port of entry for the infection in two. One had an epidural abscess with serous encephalo meningitis affecting the left temporal lobe (aphasia) and medulla (vestibular symptoms). The fifth case suffered from a cerebellar abscess. The latter, and the two patients with labyrinthine meningitis died. The cause of death in one was a circumscribed, serous, cystic arachnoiditis of the lateral cistern, this being a late sequela of a healed suppurative lepto meningitis.

In two instances, the complication attended an acute exacerbation and in one an acute recurrence of an old otitis.

The influence of the season of the year, climate and locality is discussed.

The degree of mastoid pneumatization has no effect on the liability to complication development, but affects the nature thereof. In sclerotic mastoid, the labyrinth tends to become infected, whereas in cellular processes the structures lying more posteriorly tend to become involved.

In the second part of the paper, the causes, clinical course and treatment of the "acute otogenous retrolabyrinth complex" are discussed. This symptom complex may be caused either by an allergic inflammation for which the name "meningitis serosa" is given, or by adhesions in the arachnoid causing obstruction to the circulation of cerebrospinal fluid with the usual sequelae. The latter condition is referred to as "arachnoiditis circumscripta". It is possible that the use of sulphonamides may favour the development of this complication.

The symptoms are those of cerebellar abscess, and the differential diagnosis, which may be very difficult is detailed.

Treatment of the allergic form consists in the removal of the causal septic focus, reduction of fluid intake, and the administration of dextrose, calcium and pyramidon. Post-meningitic arachnoiditis may demand cisternal puncture, inflation with air, and drainage of cerebrospinal fluid according to Meurman. If the ostium of the fourth ventricle is closed, the posterior cranial fossa must be laid wide open.

DEREK BROWN KELLY

Abstracts

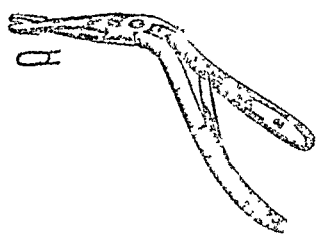
On the applicability of Ventriculo- and Encephalography in Oto-rhinology.
O. NOVOTNY (Vienna). *Monatsschrift für Ohrenheilkunde*, 1948, lxxxii,
101.

The use of contrast media (ventriculo-, encephalo-, and arteriography) in the localization of brain tumours is now common in neuro-surgery. Little use of the method has been made in oto-rhinology. This paper sets out the experiences gained in the Ear Clinic of the University of Vienna. It contains nine case reports and is illustrated with diagrams and X-ray pictures.

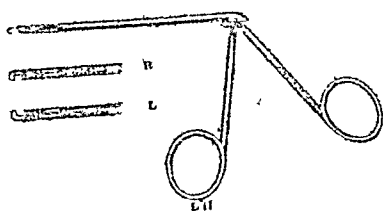
The use of air as a contrast medium in the acute stage of a brain abscess may be useful for localization, but is extremely dangerous. In view of the possible development of acute diffuse swelling of the brain, it should only be employed when other methods of localization have failed, and one is prepared to carry out immediate operation. Proof puncture of the brain is preferred as being less hazardous.

In the latent stage of brain abscess, however, or in obscure cerebral conditions without pressure signs, injection of air is a relatively harmless diagnostic method. It is specially indicated when fleeting initial cerebral symptoms suggest a developing endocranial complication in the absence of definite clinical signs.

DEREK BROWN KELLY.



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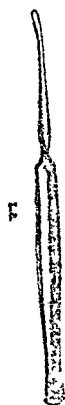
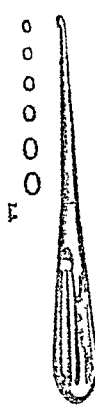
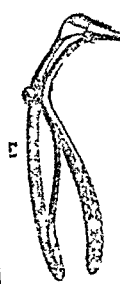
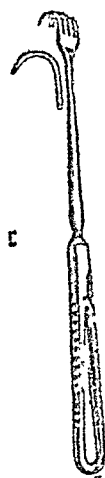
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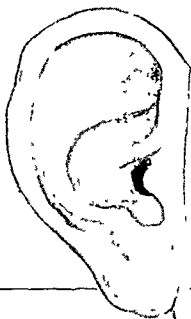
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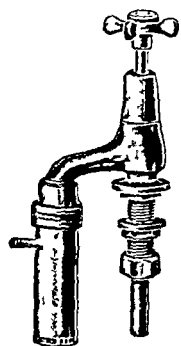
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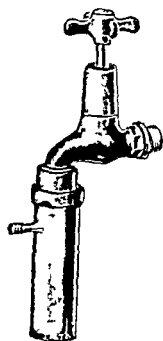
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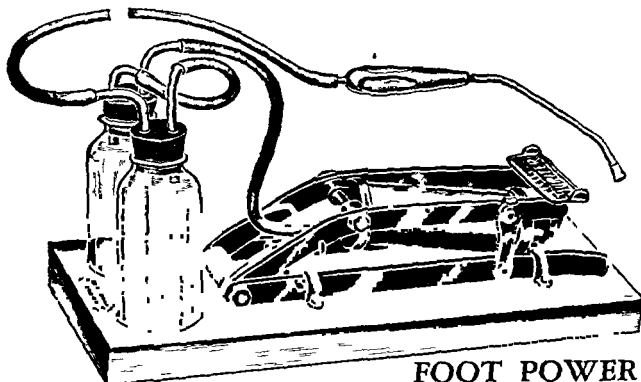


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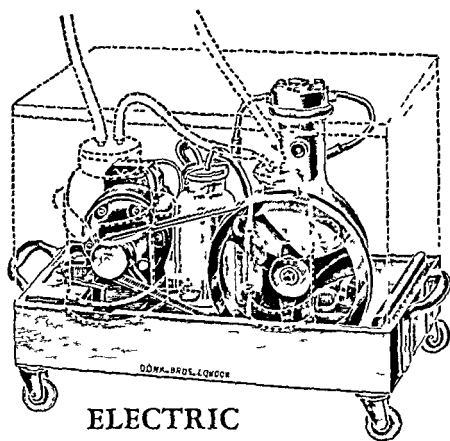
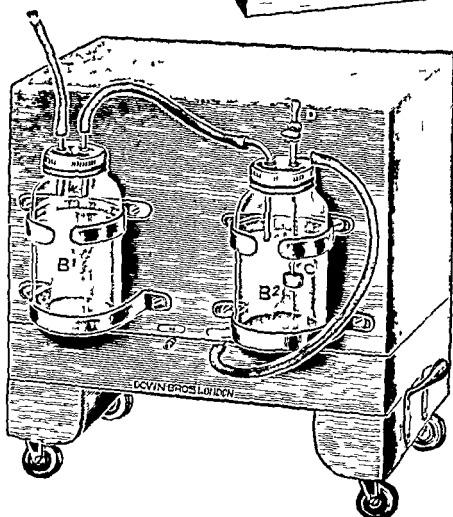


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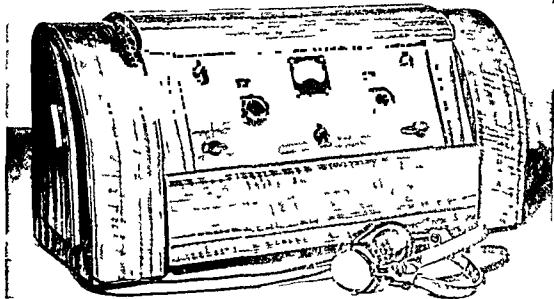
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The Journal of Laryngology and Otology

(Founded in 1887 by MORELL MACKENZIE and NORRIS WOLFENDEN)

August 1948

EXPERIMENTAL STUDIES ON THE RELIABILITY OF AUDIOMETRY*

By Flying Officer R E C BROWN

Introduction by Air Commodore E D D DICKSON

I INTRODUCTION

AUDIOMETRY was designed to reveal accurate information concerning the acuity of hearing. This information to be of any value, is dependant on the intelligent use of the audiometer and the reliability of the examiner conducting the tests. The assimilation of the details in the book of instructions supplied by the manufacturer, important though it is for manipulating and maintaining the instrument, does not constitute the whole practice of audiometry. It should be appreciated that the manufacturer is not an Otologist and should not be expected to understand the clinical significance of results. The examiner should know the variations which may be secured by audiometry and must master certain principles of technique involved in conducting the tests. The co operation and attention of the listener are essential as in all subjective tests, and his reactions should be observed at all times. This means familiarity of the examiner with the manipulation of the audiometer and a knowledge of the psychological principles involved in the act of hearing.

It is generally accepted that the results of clinical pure tone audiometry, if conducted under standard conditions by trained examiners using standardized audiometers and a careful technique, have a considerable degree of reliability but that some variability in the measurement is to be expected. (By reliability is meant the ability to obtain closely similar results for two consecutive audiograms of the same subject.)

The object of the experiments to be described in the accompanying paper was to establish the extent of this variability and if possible to evaluate the most important factors which might be responsible for it.

* This research work has been carried out in the Acoustics Laboratory Department of Otorhino laryngology Royal Air Force Central Medical Establishment

This research was undertaken by Flying Officer R. E. C. Brown of the Acoustics Laboratory of the Department of Otolaryngology, Central Medical Establishment, Royal Air Force. The clinical examination of patients was carried out by the clinical staff of the Department.

Four experiments were carried out :

1. To show the variation which occurs between measurements of hearing loss for a subject tested twice under similar conditions but each time using a different audiometer and operator.
2. To show the variations which occur between measurements of hearing loss for a subject tested twice on the same audiometer but each time using different operators.
3. To determine if a subject is affected by practice and tends to produce a lower value of hearing loss when a repeat measurement is carried out and at the same time to show the variations which occur between measurements of hearing loss for a subject tested twice using the same audiometer and operator each time.
4. To check the threshold calibrations of the two audiometers used in the experiments.

All the measurements were carried out under standard conditions similar to those existing in the clinical examination of hearing in the Department. The hearing losses recorded were of various types and were fairly representative of those usually encountered in clinical work.

Only air conduction measurements were carried out and no attempt was made to deal with the more difficult problems of bone conduction measurements. As much information as possible has been given about subjects undergoing the experiments since it was felt that it might be of use to other workers engaged in problems similar in nature to those described in this report.

Experiment I

2. AGREEMENT BETWEEN TWO SIMILAR MEASURING SYSTEMS

In this experiment an attempt has been made to show what order of agreement can be expected between two audiograms obtained on similar measuring systems. The term "measuring system" is used here to denote a system comprising a quiet testing booth, an audiometer and an operator to obtain the audiograms.

The purpose of this experiment was to obtain some idea of the variations which could be expected between the two sets of results obtained when a person has his hearing tested at one place and is then re-tested at another where the testing conditions are approximately the same. In order to do this the audiograms for a group of subjects were measured first on one system and then on the other and the results obtained were compared.

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One method by which the results might be compared would be to take a mean figure for the audiogram of each subject's hearing loss obtained for each system, and then see how well the two sets of figures agreed. This might be a satisfactory method on which to base a comparison of the audiogram given by the two measuring systems but it was felt that more information would be obtained about the measurements if an alternative method were used in which the agreements for the hearing losses measured at the individual frequencies were compared. It might be that the hearing losses obtained at one frequency were more repeatable than those obtained at another and this could not be determined using the first method.

Therefore, the latter method was used with the object of showing how the agreement of the hearing losses for the two systems varied with the frequency of the testing tone and to see what the magnitude of the difference was between the two sets of measurements at each of the test frequencies.

A brief description of the two measuring systems used for obtaining the results will now be given, together with measurements made of the ambient noise present in the testing booths during the experiments.

Measuring system (A)

This consisted of a Western Electric 6A model 215 Pure Tone Audiometer housed in a small testing booth of internal dimensions, height 9 ft, length $5\frac{1}{2}$ ft and width 5 ft. The inside walls and ceiling of the booth were padded with a sound absorbent material, to help reduce the background noise inside the booth to a level suitable for carrying out audiometric measurements. This small testing booth was located in one corner of the Consultant's examination room which is situated in a relatively quiet part of the building.

Measurements of the ambient noise present in the booth were made using a General Radio Sound Level Meter Type 759B. The average intensity level of the noise, above a reference level of 0.0002 dynes/cm², was 45 decibels, the intensity at times fluctuating by 5 decibels above and below this figure. The loudness level corresponding to the average intensity was measured by setting the weighting network on the Sound Level Meter to the 40 decibel contour position and noting the reading on the meter. This gave a loudness level of 25 decibels above the threshold of hearing.

The tests were carried out by an operator whose full time duties consisted of making all the clinical audiometric measurements on patients reporting to the department for examination of their hearing. These measurements have, for some considerable time, formed an integral part of the routine clinical examinations carried out in the Ear, Nose and Throat Department.

Measuring system (B)

This was arranged to resemble system (A) and consisted of a testing booth, a Western Electric 6A model 215 Audiometer and a different operator. The booth was, however, slightly more elaborate in construction than the one used in system (A), its internal dimensions being height $7\frac{1}{2}$ ft., length 6 ft. and width 6 ft. The interior walls and ceiling were lined with varnished plywood and the walls were then covered with heavy cloth curtains to increase their sound absorption properties. The booth was situated in the Acoustics Laboratory which is in the same part of the building as the E.N.T. Consultant's examination room.

Using the Sound Level Meter as before, the average intensity of the noise inside the booth was found to be 43 decibels above the standard reference level or 23 decibels above the threshold of hearing. In this booth the fluctuations in the intensity of the noise from time to time were less than those found in the booth of system (A) since they seldom exceeded 3 decibels.

2A. METHOD OF MEASUREMENT

The method used by the different operators in obtaining the audiograms of the subjects was as follows :

It was explained to the subject that the purpose of the test was to measure the faintest sound that he could hear at different frequencies and that the accuracy of the results depended upon his willingness to co-operate. He was then seated on the opposite side of the audiometer to the operator in such a position that he could not see the control panel. The method of showing whether or not he heard the tone was described to him. He was then instructed to hold the receiver against the ear to be tested so that the ring of soft rubber attached to the receiver formed a good seal against the ear. The frequency dial was adjusted to the frequency required and the intensity control turned to a point where the subject could easily hear the tone. The tone was then interrupted by pressing the interrupter switch in order to check that the subject was signalling in the correct manner. The intensity was decreased and the tone interrupted as before. This was continued until a point was reached where the subject's signalling no longer synchronized with the tone interruptions. The intensity was then increased by small amounts until a point was reached where the signal and tone interruptions were synchronized. This point was taken as indicating the subject's threshold for that particular frequency and the reading corresponding to the nearest 5 decibel line on the intensity dial was noted.

It is recommended by many otologists that, when measuring the air conduction hearing loss of a subject whose ears show a difference in sensitivity of approximately 50 decibels at one or more frequencies, a masking noise should be applied to the more sensitive ear while the

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other is being tested. This is to prevent a spuriously low threshold reading being obtained for the bad ear, because the sound at this intensity is conveyed by bone conduction to the good ear; without masking noise in the good ear the true threshold for the bad ear will not be determined. Since masking noise was not used, any subject whose hearing threshold differed by an amount greater than 45 decibels at any one frequency was excluded from the experiment, although it might have been justifiable to include results for such subjects, since the measurements being made were purely comparative.

2B. SUBJECTS

The subjects used in this investigation were Royal Air Force personnel reporting to the Consultant in Oto-rhino-laryngology for treatment and assessment of their medical condition.

TABLE I

Case No	Clinical type of Deafness	Aetiology	Case No	Clinical type of Deafness	Aetiology
1	Perception	Otitic Barotrauma	16	Normal	Ex Otitic Barotrauma
2	Normal	Ex Otitic Barotrauma	17	Conduction	Inactive C S O M
3	Perception	Otitic Barotrauma	18	Conduction	Otosclerosis
4	Normal	Sinusitis	19	Conduction	Ex Otitic Barotrauma
5	Conduction	Otosclerosis	20	Conduction	Inactive C S O M
6	Perception	Ex Otitic Barotrauma	21	Perception	Ménière's Syndrome
7	Normal	Ex Otitic Barotrauma	22	Mixed	Inactive C S O M
8	Mixed	Active C S O M	23	Perception	Aviation Noise Deafness
9	Normal	Dry Perforation T M Rt	24	Perception	Aviation Noise Deafness
10	Perception	Fractured Skull	25	Perception	Inactive C S O M
11	Conduction	Otosclerosis	26	Conduction	Otosclerosis
12	Perception	Inner Ear Deafness	27	Conduction	Inactive C S O M
13	Perception	Inner Ear Deafness	28	Normal	Ex Ruptured T M
14	Conduction	Inactive C S O M	29	Perception	Aviation Noise Deafness
15	Conduction	Inactive C S O M	30	Perception	Sinusitis

A test group of thirty subjects with varying degrees of deafness was used and Table I shows a list of the subjects with a clinical diagnosis for each one. The hearing losses have been divided, from the deafness point of view, into four classes and of the total number of cases tested the number falling into each class was as follows:

(a)	Perception deafness	..	..	12
(b)	Conduction deafness	..	..	10
(c)	Mixed deafness	..	..	2
(d)	Normal hearing	..	..	6

TABLE 2.

SUBJECT	HEARING LOSS IN DECIBELS													
	128 CPS.		256 CPS.		512 CPS.		1024 CPS.		2048 CPS.		4096 CPS.		8192 CPS.	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
1 Right Ear	10	5	5	5	10	5	0	5	0	-5	0	5	35	35
1 Left Ear	5	0	10	5	5	0	5	0	0	-5	10	5	25	15
2 Right Ear	10	0	10	10	15	10	10	10	10	0	0	5	5	0
2 Left Ear	5	5	5	5	10	5	5	0	5	0	10	5	15	10
3 Right Ear	5	0	10	5	5	0	5	0	5	0	45	35	10	30
3 Left Ear	15	5	10	5	15	5	10	0	5	0	45	45	5	15
4 Right Ear	5	0	5	0	5	-5	10	5	10	5	10	5	25	20
4 Left Ear	5	0	10	0	5	0	5	5	10	5	20	15	20	15
5 Right Ear	15	10	25	10	25	10	30	10	10	10	20	10	30	20
5 Left Ear	20	5	20	5	15	10	20	10	15	5	15	10	30	10
6 Right Ear	5	5	10	5	5	10	5	10	0	0	20	15	35	25
6 Left Ear	5	0	5	5	5	0	0	5	0	0	10	10	5	15
7 Right Ear	5	5	10	10	10	10	5	10	0	-5	10	5	20	15
7 Left Ear	0	10	10	10	5	5	10	5	5	0	5	0	5	0
8 Right Ear	50	40	65	60	70	60	80	65	75	70	75	65	65	55
8 Left Ear	25	20	30	25	25	15	45	40	70	60	90	70	85	70
9 Right Ear	5	5	10	10	15	10	5	10	5	5	5	5	25	20
9 Left Ear	0	5	5	5	5	0	5	0	0	-5	5	10	10	5
10 Right Ear	40	50	50	55	55	55	50	60	45	65	60	65	65	75
10 Left Ear	10	10	10	15	10	10	5	10	0	10	0	10	10	10
11 Right Ear	35	25	30	30	45	30	35	30	25	25	20	15	40	30
11 Left Ear	35	20	45	35	50	40	45	30	35	30	35	30	35	15
12 Right Ear	5	0	0	5	5	-5	5	0	0	0	10	0	5	0
12 Left Ear	10	0	15	5	10	0	5	0	30	20	35	0	60	40
13 Right Ear	35	25	30	35	35	35	45	40	50	35	45	40	60	40
13 Left Ear	35	30	40	40	35	50	45	45	40	50	40	40	40	55
14 Right Ear	5	0	5	5	5	0	5	-5	0	-5	25	25	0	-5
14 Left Ear	20	25	25	25	20	20	25	20	20	10	40	25	40	25
15 Right Ear	60	60	60	65	65	65	60	70	55	65	60	60	70	70
15 Left Ear	10	5	10	5	15	5	15	5	20	20	15	5	10	15
16 Right Ear	5	15	5	0	5	0	5	0	5	0	10	5	0	0
16 Left Ear	5	15	5	5	0	0	0	0	5	0	5	0	5	0
17 Right Ear	10	10	15	10	10	5	10	5	15	15	20	10	30	10
17 Left Ear	10	20	10	5	5	5	10	5	5	0	10	0	5	0
18 Right Ear	60	60	60	45	60	55	60	45	45	30	35	25	40	30
18 Left Ear	50	55	55	55	55	40	60	35	45	40	35	30	35	30
19 Right Ear	5	10	10	10	10	5	5	0	10	5	30	30	10	5
19 Left Ear	20	25	20	20	20	0	15	10	10	0	25	5	25	10
20 Right Ear	15	15	15	15	15	10	10	10	0	0	5	0	20	15
20 Left Ear	10	20	15	20	10	5	15	0	0	-5	5	5	5	0
21 Right Ear	30	30	30	30	35	30	45	30	40	25	65	50	70	55
21 Left Ear	20	25	25	25	25	20	30	20	25	10	50	45	35	25
22 Right Ear	0	10	5	5	0	0	5	0	10	0	10	5	20	0
22 Left Ear	35	45	40	50	40	45	25	25	15	20	60	50	40	30
23 Right Ear	5	15	10	5	10	0	10	0	5	5	60	50	70	50
23 Left Ear	5	10	5	5	10	0	5	-5	0	-5	70	65	60	55
24 Right Ear	5	5	10	0	10	0	5	0	30	20	65	50	50	40
24 Left Ear	5	0	10	0	0	0	0	-5	0	-5	55	40	20	0
25 Right Ear	30	35	30	35	25	30	30	30	30	25	30	35	50	40
25 Left Ear	25	35	30	40	30	30	30	25	25	25	25	30	55	25
26 Right Ear	25	10	25	15	50	35	60	55	60	50	65	55	70	40
26 Left Ear	35	30	30	20	20	15	55	35	40	35	65	55	60	60
27 Right Ear	5	5	5	5	5	0	0	0	0	0	0	0	0	0
27 Left Ear	30	15	35	25	25	20	20	20	25	20	35	20	35	25
28 Right Ear	20	0	5	0	5	0	5	0	5	0	5	0	5	15
28 Left Ear	25	0	10	0	5	0	10	0	5	0	10	0	10	0
29 Right Ear	10	15	35	10	65	55	65	60	55	60	90	N.R.	N.R.	80
29 Left Ear	10	5	20	5	20	5	20	10	20	5	45	45	50	25
30 Right Ear	5	0	5	0	5	0	0	0	0	5	25	30	45	35
30 Left Ear	5	0	5	0	10	0	10	0	5	0	5	0	30	25

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For the purposes of this experiment, a person is said to have normal hearing at threshold, if there is nothing clinically wrong with his ears and if he also passes the 20 ft forced whisper test and gives a normal response to tuning fork tests

2C TESTING PROCEDURE

The hearing loss of the 30 subjects was measured for the seven frequencies in the octave range 128-8192 cps. The right and left ear of each subject was tested separately and the time taken to measure the hearing loss of each ear for the seven test frequencies was about seven minutes. The routine adopted in carrying out the measurements was as follows

The subject's audiogram was first obtained using measuring system (A) and he was then sent to the specialist in Oto-rhino-laryngology for examination. When the specialist had completed his examination, the subject was sent to the Acoustics Laboratory where a repeat measurement was made on system (B). No information regarding the subject's hearing condition was conveyed to the operator, as it was thought that this might influence the results of the second measurement.

If any subject had, during the course of his examination by the medical specialist, received treatment that might have produced a change in his hearing condition he was not allowed to proceed with the second measurement. The time which elapsed between the two series of measurements, for any one subject, did not exceed twenty five minutes, and it was assumed that no change in the subject's hearing had taken place during this time.

2D RESULTS

The manner in which the audiograms were recorded is shown in Table 2. The hearing losses in decibels for the same ear on the two systems are shown listed side by side in the columns headed (A) and (B). This has been done for each of the frequencies used in the test.

For each frequency a graph has been plotted to show how the hearing losses obtained on the two systems agree (see Fig 1). Beside each graph is a histogram showing the number of times a particular difference occurred between the two sets of results at this frequency. In comparing the results the ears have been treated as separate units, therefore each graph and histogram represents the measurements for 60 ears.

With reference to the graphs, points falling on the diagonal line on each graph represent perfect agreement for the two systems and it will be seen how the results scatter about this line. At all the frequencies, there is a marked tendency for the points to fall below, and parallel to, the diagonal line. This indicates that, for the majority of the ears tested, system (B) gave a lower value of hearing loss. Also, the fact

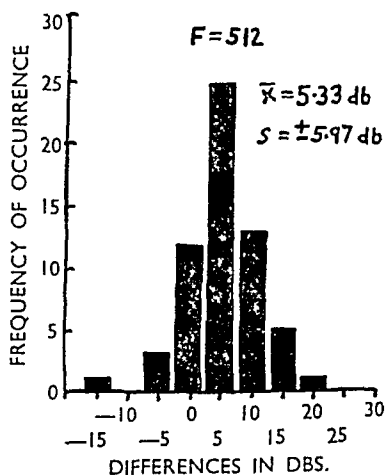
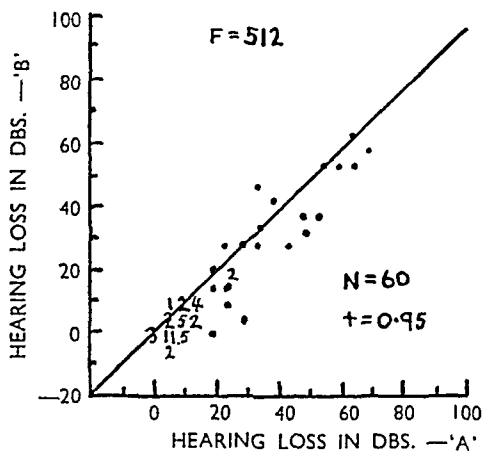
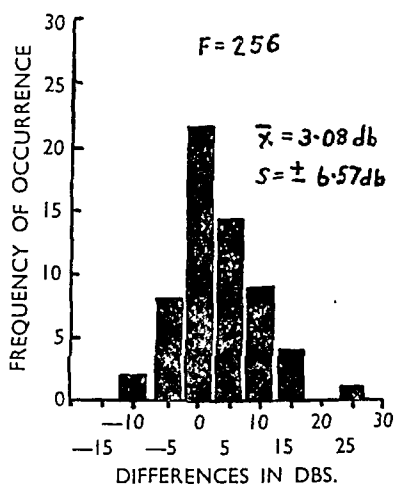
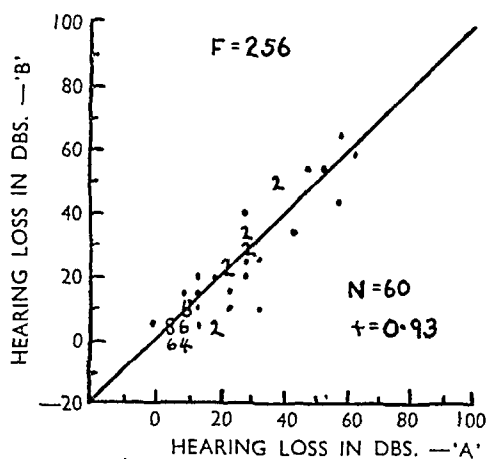
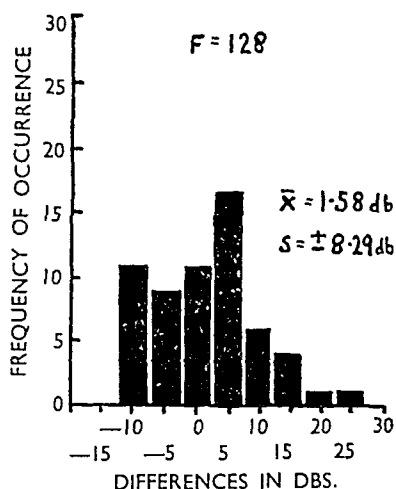
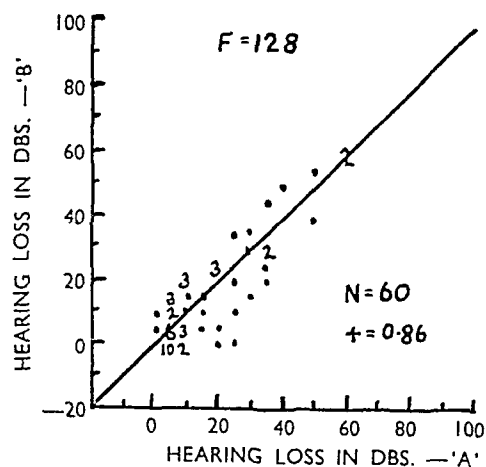


FIG. 1a.

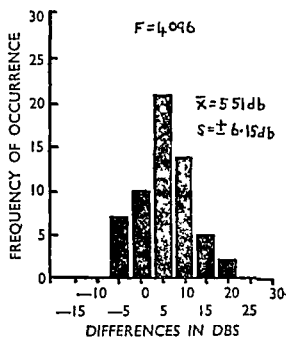
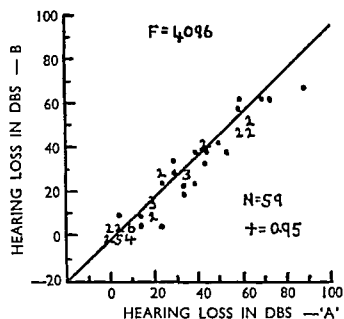
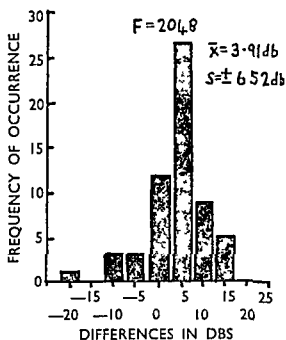
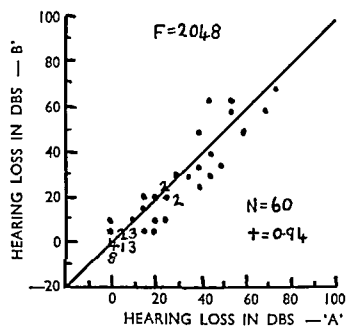
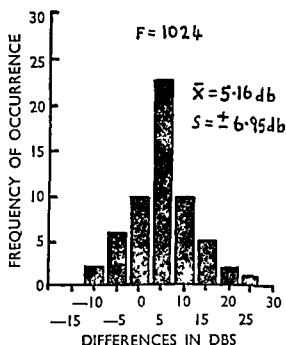
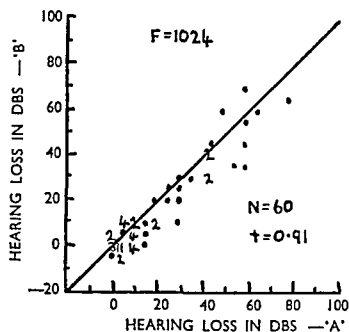


FIG 1b
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R. E. C. Brown

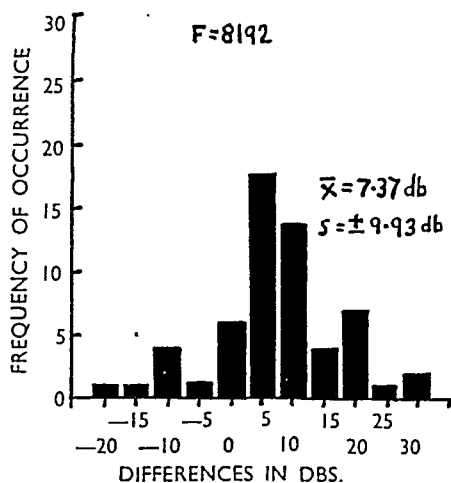
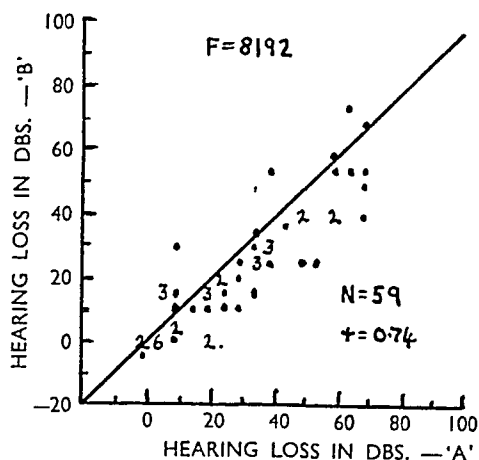


FIG 1c.

that these points tend to form a straight line indicates a high degree of correlation between the two sets of measurements.

In order to show how the agreement between the measurements varied with the test frequency, the product moment correlation coefficient (r) was calculated for each frequency, assuming a linear relationship between the two variables, and is given on the graphs.

Examination of the coefficients for the frequencies 256, 512, 1024, 2048, and 4096 c.p.s. shows that there is no significant difference between the values of (r) and therefore there is equal agreement between the results for each of these frequencies. For the frequencies 128 and 8192 c.p.s. the values of (r) are lower and significantly different from those of the other frequencies. This suggests that the agreement between the results for the two measuring systems depends upon the test

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frequency used For the five frequencies in the octave range 256-4096 c p s the agreement is very high but decreases for frequencies above and below this range This point is brought out more clearly by means of the histograms representing the differences obtained for the separate frequencies

The mean product moment correlation coefficient giving the agreement between the two systems for all the test frequencies has been calculated from the chart of Fig 2 The value of (r) was 0.921, i e more than 100 times the value of its standard error As an (r) twice the value of its standard error is significant for a probability of 1 in 20, it is obvious that the degree of correlation is extremely high By a probability of 1 in 20 is meant that, if the measurements were repeated a number of times, deviations greater than those observed would occur on the average about once in every 20 tests

For six out of the seven distributions shown in Fig 1 the most frequently occurring difference is 5 decibels and the distributions will be seen to be shifted in a positive direction relative to zero db on the difference scale A positive difference indicates that the value of hearing loss obtained was greater for system (A) If the two measuring systems were behaving in exactly the same manner, it would be reasonable to expect that the distributions would have their peaks at zero In order to determine if this shift was a significant indication of an effect operating in the experiment, the histograms were subjected to statistical analysis

All data referring to the histograms are shown in Table 3 The various statistical factors have been calculated, assuming a normal distribution for each histogram This assumption is approximately true, except for the histogram corresponding to frequency 128 As this histogram shows a wide departure from a normal distribution, use of statistical methods based on normality are, in this case, not strictly justified However, frequency 128 has been treated as a normal distribution in order to obtain a rough indication of the behaviour of the two systems at this frequency

TABLE 3

Frequency c p s	No of Results (N)	Mean Value X	Standard Error X	Standard Deviation (S)	Range of Distri- bution	Result of t test
128	60	1 58	± 1 07	± 8 29	35	N S
256	60	3 08	± 0 85	± 6 57	35	S
512	60	5 33	± 0 77	± 5 97	35	S
1024	60	5 16	± 0 90	± 6 95	35	S
2048	60	3 91	± 0 84	± 6 52	35	S
4096	59	5 51	± 0 79	± 6 15	25	S
8192	59	7 37	± 1 28	± 9 93	50	S

N S =Not Significant

S=Significant

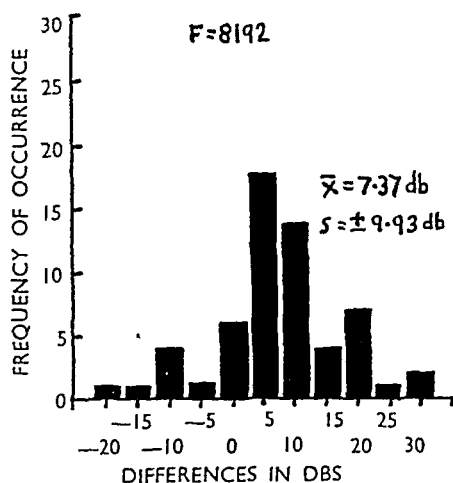
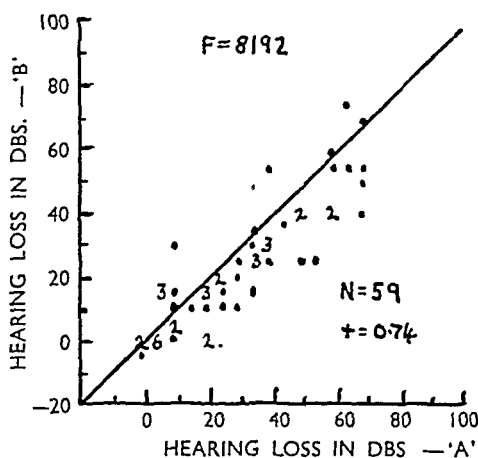


FIG 1C.

that these points tend to form a straight line indicates a high degree of correlation between the two sets of measurements.

In order to show how the agreement between the measurements varied with the test frequency, the product moment correlation coefficient (r) was calculated for each frequency, assuming a linear relationship between the two variables, and is given on the graphs.

Examination of the coefficients for the frequencies 256, 512, 1024, 2048, and 4096 c.p.s. shows that there is no significant difference between the values of (r) and therefore there is equal agreement between the results for each of these frequencies. For the frequencies 128 and 8192 c.p.s. the values of (r) are lower and significantly different from those of the other frequencies. This suggests that the agreement between the results for the two measuring systems depends upon the test

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From Table 3 it will be seen how the mean values (\bar{X}) and the standard deviations of the histograms vary with frequency. As the standard errors of the means are small, the mean values of the differences are significantly different from zero and unlikely to be due to the operation of pure chance, except for the frequency 128 c.p.s. This is borne out by results of the "t" test which is a statistical test for determining

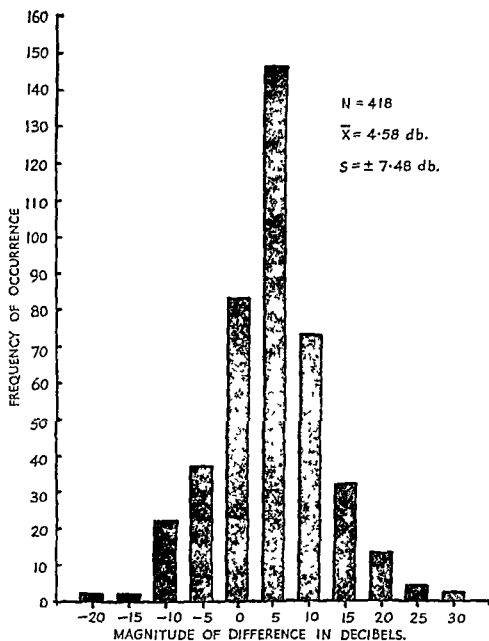


FIG 3

whether a mean value is significantly different from zero. For the histogram of frequency 128, the scatter of the data relative to the mean is so great that the mean value is not a reliable indication of the difference between the two systems at this frequency. With the exception of the lowest and highest frequencies, the standard deviations are very nearly the same.

For the test frequency 128 c.p.s. a possible explanation for the large value of the standard deviation is that the intensity of the low frequency

ambient noise present in one of the two booths changed suddenly from its average intensity to some other value. The probability that this was so is indicated by the fact that the differences between the results of the first 20 subjects show a distribution similar to that for other frequencies and it is only when the differences between the results for the last ten subjects are included that the histogram departs widely from a normal distribution. It appears from this that a change occurred in the testing conditions towards the end of the experiment which affected the results at this frequency.

The frequency distributions of Fig. 1 have been added together to form a single histogram. This is shown in Fig. 3 and represents the differences obtained for the seven test frequencies. As might be expected from Fig. 1 this histogram shows that 5 db. was the most frequently occurring difference, the other differences being almost equally distributed in both directions about this point. At the same time if all the differences within the range -10 db. to $+10$ db. are added together they account for 85 per cent. of the total number. It will also be seen that differences as large as 30 db. occurred between successive measurements of a hearing loss but this only happened twice in 418 results. The mean value of the differences was 4.58 db., the standard error being ± 0.39 db. and the standard deviation ± 7.48 db.

One interesting result of this first experiment is indicated in the histogram shown in figure 3. The most frequently occurring difference is $+5$ db. and this shows that there is a consistent difference between the results obtained with the two measuring systems. Further experiments were planned to examine the effect of various factors upon the audiometric measurements and it was expected that these experiments would also indicate the reason for this consistent difference.

Experiment II

3. DIFFERENCE BETWEEN OPERATORS

The technique used when measuring a subject's hearing loss may vary considerably. For example, in the previous experiment, the technique employed by the two operators was not the same in that the operator of system (A) always commenced at the middle frequency 1024 c.p.s. proceeding in octave steps to 8192 c.p.s. and then from 512 in octave steps down to 128 c.p.s. On the other hand, the operator of system (B) commenced at the frequency 128 and continued in octave steps to 8192 c.p.s. Another factor in the technique is the length of time for which the ear is stimulated by the pure tone. Since the machine was operated manually the time for which the tone was given depended upon the operator and could, therefore, have varied within wide limits. This time factor can be important in determining the value of the hearing loss when approaching the threshold of hearing.

Experimental Studies on Reliability of Audiometry

Then there is the point of experience to be considered. For instance, one operator had clinical experience of audiometry covering a period of nine years, but the other, whilst being associated with methods of measuring hearing, had never regularly used a pure tone audiometer before. Therefore, owing to the large difference in experience between the operators and such points as those mentioned above, the following experiment was carried out with the object of determining the effect of changing the operator.

In this investigation both operators measured the audiograms of a group of subjects under the same testing conditions and a comparison of the results was made. Since the testing conditions were the same in both cases then any significant difference between the results was a measure of the difference between the operators.

When measuring the audiogram, the method employed was the same as that described in Section 2A and, as before, 30 subjects drawn from a similar population were used.

The operators are here referred to as " O_A " and " O_B ", " O_A " being the operator of system (A) in the first experiment and " O_B " the operator of system (B).

3A SUBJECTS

A list of the subjects, with a clinical diagnosis for each one is given in Table 4, and, separating the types of deafness into the same four categories as before, it was found that the numbers falling into each class were as follows

(a) Perception deafness	11
(b) Conduction deafness	10
(c) Mixed deafness	2
(d) Normal hearing	7

It will be observed that the numbers occurring in each class for this and the previous experiment show good agreement.

3B TESTING PROCEDURE

This was the same as that mentioned in Section 2B, but with the following exceptions

- 1 Both operators used the same pure tone audiometer and testing booth described in measuring system (A)
- 2 It was arranged that practice effect, if any, between the first and second measurements of an audiogram should operate in such a manner as to affect the results obtained by the two operators to the same extent. This was achieved by allowing one half of the subjects to have their hearing tested first by operator " O_A " and the other half to be given the first test by operator " O_B ".

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Experimental Studies on Reliability of Audiometry

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3B TESTING PROCEDURE

This was the same as that mentioned in Section 2B, but with the following exceptions

- 1 Both operators used the same pure tone audiometer and testing booth described in measuring system (A)
- 2 It was arranged that practice effect if any between the first and second measurements of an audiogram should operate in such a manner as to affect the results obtained by the two operators to the same extent. This was achieved by allowing one half of the subjects to have their hearing tested first by operator O_A ' and the other half to be given the first test by operator O_B '.

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TABLE 4.

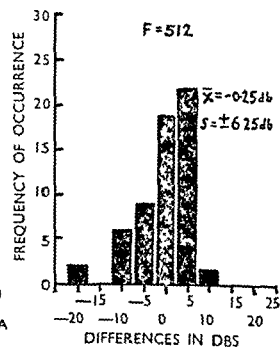
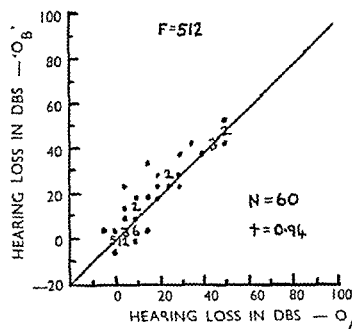
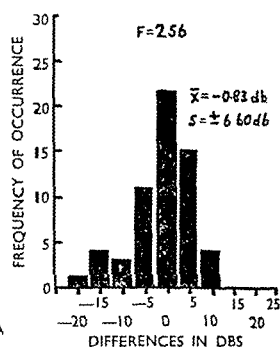
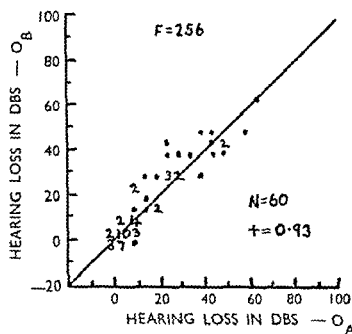
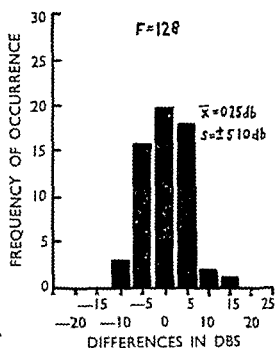
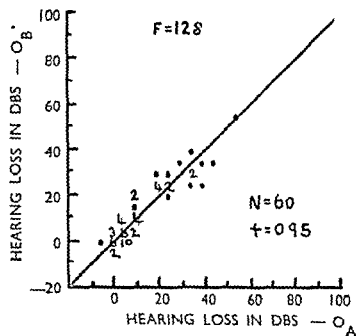
Case No.	Clinical type of Deafness	Aetiology	Case No.	Clinical type of Deafness	Aetiology
1.	Conduction	Inactive C.S.O.M.	16.	Perception	Shell explosion
2.	Perception	Aviation noise deafness	17.	Normal	Inactive C.S.O.M.
3.	Perception	Not known	18.	Perception	Bomb explosion
4.	Conduction	Middle Ear deafness	19.	Conduction	Not known
5.	Perception	Not known	20.	Conduction	Perforation Rt. T.M.
6.	Conduction	Inactive C.S.O.M.	21.	Conduction	Fibrosis-middle ear
7.	Normal	Perforation Rt. Tympanic Membrane	22.	Perception	Active C.S.O.M.
8.	Perception	Inactive C.S.O.M.	23.	Perception	Aviation noise deafness
9.	Perception	Aviation noise deafness	24.	Normal	External otitis
10.	Normal	Otitic barotrauma	25.	Mixed	Not known
11.	Mixed	Nasal obstruction	26.	Normal	Otitic barotrauma
12.	Perception	Aviation noise deafness	27.	Conduction	Otosclerosis
13.	Conduction	Otosclerosis	28.	Normal	Otitic barotrauma
14.	Conduction	Active C.S.O.M.	29.	Normal	Not known
15.	Perception	Aviation noise deafness	30.	Conduction	Not known

3C. RESULTS

The audiograms obtained are shown tabulated in Table 5. The hearing loss in decibels obtained by the two operators for the same ear are shown listed side by side in columns headed " O_A " and " O_B ". These results are shown in graphical form in Fig. 4, and, as before, a separate graph and frequency distribution have been drawn for each frequency showing how well the hearing losses obtained by the operators agreed, and the number of times a particular difference between their results occurred. A positive difference indicates that a lower value of hearing loss was obtained by operator " O_B ".

With reference to the graphs, points falling on the diagonal line represent perfect agreement between the two sets of measurements and it will be seen that for each graph the points tend to distribute themselves evenly about this line. The correlation coefficient " r " has been calculated for each frequency and is shown listed on the appropriate graph. No significant difference exists between the separate values of " r ", therefore, the degree of agreement between the two sets of results for each frequency is the same. Examination of the coefficients shows that they are, in general, higher than those obtained for the graphs of Fig. 1.

Since the agreement is the same for all the frequencies it follows that, although the background noise present in the testing booth was low



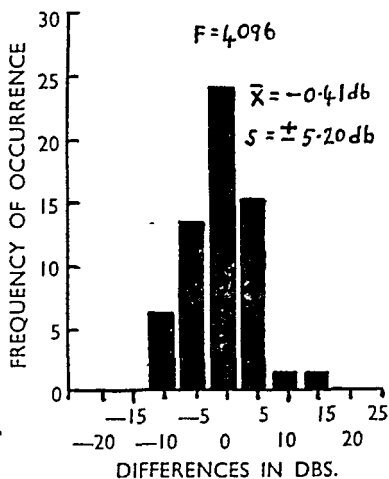
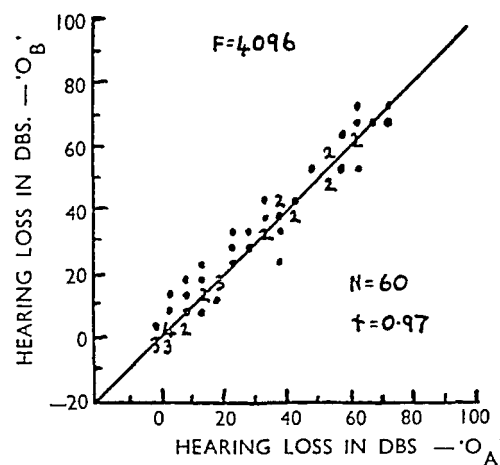
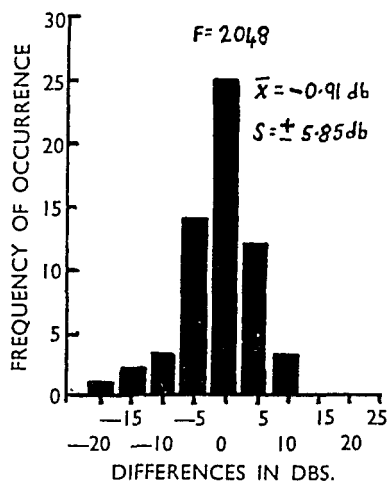
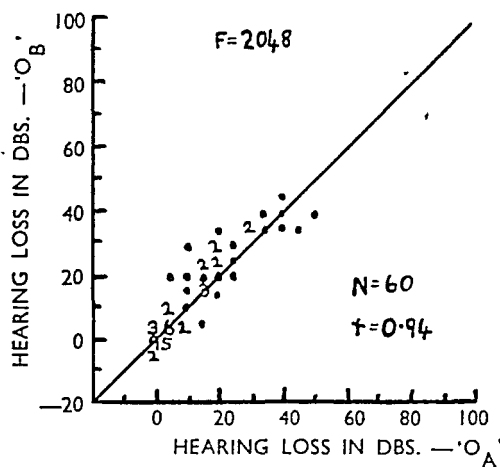
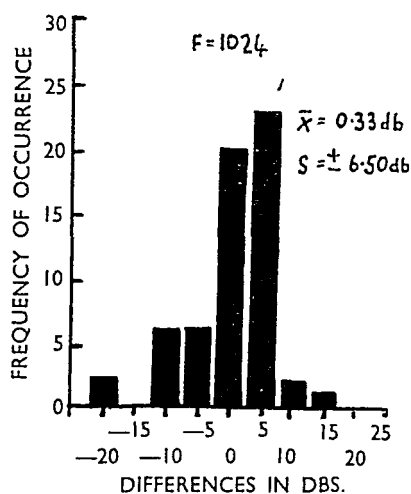
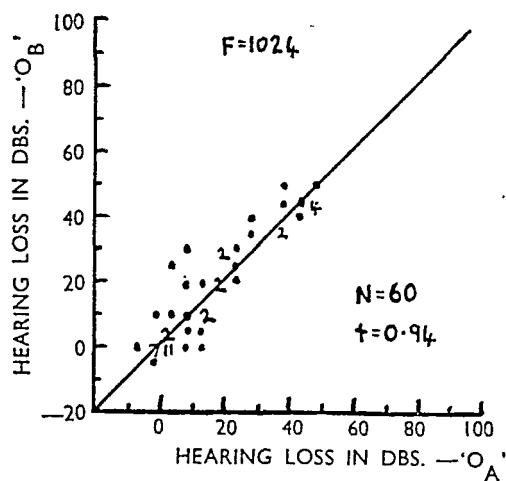


FIG. 4b.
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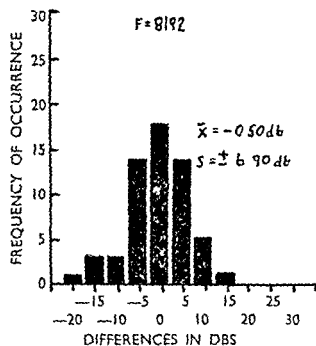
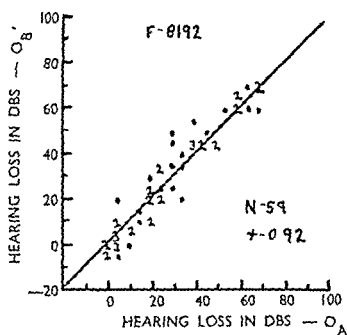


Fig 4c

frequency in character, variations in its intensity did not have the effect of producing a larger scatter in the results for the lower frequencies. It will be remembered that the ambient noise, as measured by the General Radio Sound Level meter, fluctuated between 40 and 50 db above the standard reference level, and it seems that a variation in the noise intensity of this order may be tolerated without affecting the reliability of measurements made in the frequency range 128-8192 cps.

From the chart of Fig 5 the mean correlation coefficient for the seven test frequencies has been calculated, giving the agreement between the results of the two operators. This gave a value for " r " of 0.950. This value is significantly higher than that obtained for the corresponding value of " r " in the previous experiment (see Fig 2) indicating that

TABLE 5.

SUBJECT	HEARING LOSS IN DECIBELS.															
	128 CPS.		256 CPS.		512 CPS.		1024 CPS.		2048 CPS.		4096 CPS.		8192 CPS.			
	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
1 Right Ear	10	10	10	10	10	10	15	5	5	5	15	10	60	60		
Left Ear	40	35	50	45	50	45	50	45	50	40	60	55	70	60		
2 Right Ear	10	10	20	15	15	5	10	0	5	0	65	55	45	45		
Left Ear	5	5	10	5	10	5	5	0	5	5	65	65	50	45		
3 Right Ear	-5	0	0	5	-5	5	-5	0	5	10	25	30	30	45		
Left Ear	0	5	5	0	5	0	5	0	0	0	45	40	35	35		
4 Right Ear	25	20	40	30	40	40	40	50	30	35	20	20	25	20		
Left Ear	5	0	5	5	5	5	5	0	0	0	5	0	5	5		
5 Right Ear	0	5	5	0	5	0	5	5	15	15	70	70	60	60		
Left Ear	0	0	5	0	0	-5	5	0	15	25	60	65	45	45		
6 Right Ear	0	0	5	5	5	0	0	-5	5	0	5	0	20	10		
Left Ear	25	25	30	30	30	25	25	25	30	30	10	0	40	45		
7 Right Ear	10	5	15	15	10	5	5	0	10	5	10	5	20	20		
Left Ear	5	10	10	10	10	5	5	0	0	5	10	10	10	5		
8 Right Ear	5	5	0	5	5	0	5	5	5	5	75	75	65	70		
Left Ear	25	25	30	30	25	25	20	20	25	25	35	40	50	45		
9 Left Ear	0	0	5	0	5	15	30	40	40	40	20	15	5	-5		
Left Ear	5	10	10	5	5	0	0	0	15	15	35	35	5	0		
10 Right Ear	5	10	10	25	5	10	0	10	10	10	15	15	10	0		
Left Ear	5	0	10	5	10	0	15	0	15	5	5	5	5	10		
11 Right Ear	20	20	35	40	35	45	40	45	30	35	65	70	70	70		
Left Ear	10	10	25	30	20	30	20	30	15	25	40	45	60	65		
12 Right Ear	5	5	5	5	0	0	0	0	0	5	75	70	45	50		
Left Ear	5	0	10	0	5	0	0	0	5	0	35	35	15	10		
13 Right Ear	35	25	45	40	45	45	40	35	25	30	20	20	20	30		
Left Ear	45	35	60	50	50	50	50	45	45	35	45	45	40	45		
14 Right Ear	5	0	5	5	10	5	15	10	10	5	5	10	5	5		
Left Ear	20	25	30	40	25	30	45	40	40	45	40	40	40	55		
15 Right Ear	5	0	5	5	5	0	5	5	15	20	55	55	30	35		
Left Ear	5	0	5	5	5	0	10	5	20	15	65	65	65	60		
16 Right Ear	35	40	45	50	50	50	50	45	40	35	45	40	N.R.	N.R.		
Left Ear	40	25	50	45	45	45	40	35	25	20	40	25	35	20		
17 Right Ear	5	0	5	0	5	0	5	0	5	0	5	0	5	10		
Left Ear	5	5	5	5	5	0	5	0	0	-5	0	0	5	0		
18 Right Ear	10	5	20	15	10	15	15	10	20	35	90	90	75	75		
Left Ear	0	5	10	10	5	5	5	5	0	0	55	50	60	65		
19 Right Ear	35	30	45	45	50	55	50	50	35	40	55	60	50	50		
Left Ear	0	-5	0	0	0	0	0	0	0	0	65	75	70	70		
20 Right Ear	20	25	20	30	20	25	10	10	0	-5	5	5	20	10		
Left Ear	55	55	65	65	60	60	45	45	30	30	40	45	25	35		
21 Right Ear	10	10	10	10	5	5	5	10	5	5	10	5	15	15		
Left Ear	20	25	25	30	30	30	25	30	20	25	25	25	25	20		
22 Right Ear	0	-5	0	0	0	0	0	0	5	0	0	0	10	5		
Left Ear	5	0	5	0	5	0	0	0	0	5	20	20	35	40		
23 Right Ear	5	0	0	0	5	0	0	0	0	0	30	35	0	-5		
Left Ear	0	0	5	0	0	0	0	0	5	5	30	30	0	-5		
24 Right Ear	5	0	5	10	10	5	5	5	5	10	15	15	20	20		
Left Ear	0	0	5	5	10	5	5	5	0	0	15	15	25	25		
25 Right Ear	35	30	50	40	30	40	10	30	10	30	55	50	55	60		
Left Ear	20	30	25	40	15	35	10	20	5	5	55	60	30	50		
26 Right Ear	5	10	5	10	0	5	5	5	0	0	0	5	0	0		
Left Ear	5	5	5	5	0	0	5	0	0	0	0	0	5	5		
27 Right Ear	20	25	25	30	20	20	20	30	15	15	25	35	25	35		
Left Ear	25	30	25	45	25	30	30	35	20	25	35	45	40	45		
28 Right Ear	10	20	10	25	5	25	15	20	10	20	15	15	20	25		
Left Ear	10	20	15	30	15	20	20	20	10	15	15	25	5	20		
29 Right Ear	10	15	15	20	10	20	5	25	5	20	5	15	30	25		
Left Ear	0	0	5	5	5	0	0	0	0	0	5	5	5	0		
30 Right Ear	30	35	40	50	45	45	50	45	35	35	40	35	20	25		
Left Ear	5	5	10	15	10	15	25	20	20	20	5	5	0	0		

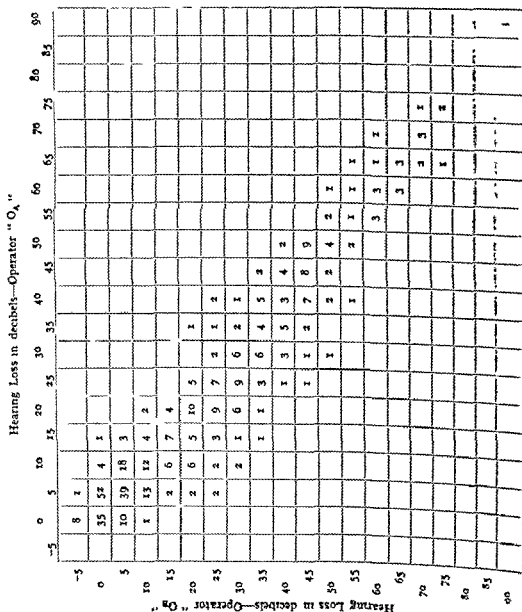
Experimental Studies on Reliability of Audiometry

Frequency Distribution of Hearing Losses

Operator "O _A " f	Operator "O _B " f
-5	-5
0	0
5	5
10	10
15	15
20	20
25	25
30	30
35	35
40	40
45	45
50	50
55	55
60	60
65	65
70	70
75	75
80	80
85	85
90	90
419	419

O_A -16.84
S -123.00

O_B -19.95
S -122.84



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slightly better agreement was obtained between consecutive measurements of a subject's hearing loss when tested under the conditions existing in this experiment. This is, indeed, what might be expected since the number of possible variables operating in this experiment was less.

Reference to the histograms of Fig. 4, representing the differences between the hearing losses, shows that each one tends to follow a normal distribution and, for five out of the seven distributions given, the peak occurs at zero db. on the difference scale.

TABLE 6.

Frequency c.p.s.	No. of Results (N)	Mean Value X	Standard Error X	Standard Deviation (S)	Range of Distri- bution	Result of " t " test
128	60	0.25	± 0.65	± 5.10	25	N.S.
256	60	-0.83	± 0.85	± 6.60	30	N.S.
512	60	-0.25	± 0.66	± 6.25	30	N.S.
1024	60	0.33	± 0.70	± 6.50	35	N.S.
2048	60	-0.91	± 0.75	± 5.85	30	N.S.
4096	60	-0.41	± 0.67	± 5.20	25	N.S.
8192	59	-0.50	± 0.90	± 6.90	35	N.S.

N.S. = Not Significant.

Table 6 lists the statistical data for the histograms and it will be seen that the mean value of each distribution is not significantly different from zero as shown by the result of the " t " test. They could, therefore, be attributed to the operation of pure chance. This means that no reliable difference exists between the results of the two operators and, therefore, the different techniques which were used do not seem to be important. Also, if we take operator " O_A ", this being the one with the greater experience, as an example of a person fully trained in pure tone audiometry then the results show that a person can in a very short time become fully competent in the use of an audiometer. It will be remembered that in the previous experiment operator " O_B " using the audiometer for the first time tested 30 subjects. Therefore, since the results obtained by the two operators in this experiment were the same it would appear that operator " O_B " after testing this number became equally efficient as operator " O_A ". It may, of course, be possible to achieve this degree of efficiency on even fewer cases but it seems that a person who is reasonably intelligent and sufficiently interested in the work will become proficient and accurate in the use of an audiometer after testing say 30 subjects. It may be argued that, owing to the large difference in the practice of audiometry between the two operators, the one with the greater experience would produce a more repeatable result. However, in Section 4 which deals with practice effect, it will be

Experimental Studies on Reliability of Audiometry

shown that the method and technique of both operators are, in fact, equally reliable. The grouped histogram of Fig 6 represents the differences obtained for the seven test frequencies. It will be seen that this histogram follows very closely that of Fig 3 with the exception that the peak of the distribution occurs at zero db and that the standard deviation is slightly smaller. The mean value of the distribution was

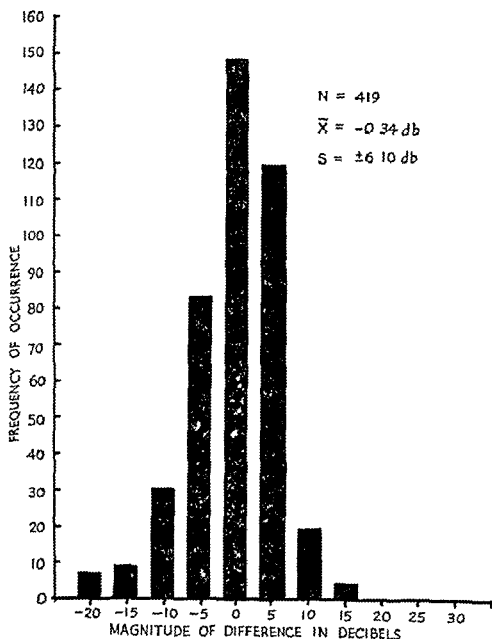


Fig 6

-0.34 db and its standard deviation ± 6.1 db. The mean value of the distribution is not significantly different from zero.

From this histogram an attempt has been made to establish approximately how great the difference between measurements of a subject's hearing loss must be in order to indicate with a fair degree of certainty, that his threshold of hearing has changed. The magnitude of this difference will largely depend upon the degree of certainty required. It is common practice with measurements of this kind to apply what is

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termed a "significance level" to the measurements and the lowest degree of certainty generally accepted is a probability of .05. Applying the .05 level of significance to the histogram of Fig. 6 shows that differences falling within the range of $\pm 2S$ from the mean value—where S is the Standard deviation—cannot be attributed to any special cause. The number of differences coming within this range make up approximately 95 per cent. of the results in the distribution, therefore 5 per cent. or one in every twenty of them fall outside this range. Differences of ± 12 db. from the mean value may therefore, be expected without indicating a change in a subject's threshold of hearing. Differences greater than this, however, may be attributed to a change of threshold, the odds against such a difference occurring by chance being at least 19 : 1.

Care must be taken in applying this reasoning to the actual audiograms since in this experiment a total of 14 results was obtained for each subject, i.e. seven results for each ear, and it is therefore, not unlikely that one of these results will deviate by an amount greater than 12 db. owing to chance. When comparing audiograms of a subject's hearing loss on the same measuring system, a working rule that might prove satisfactory is one whereby two or more consecutive differences greater than 10 db. in the same direction be taken as a reliable indication that a change in the subject's hearing has taken place. The probability of this occurring by chance is very small.

Experiment III

4. PRACTICE EFFECT

In the first experiment all the subjects were tested firstly on system (A) and then on system (B) and in no case was this order reversed. It was possible that the effect of practice on the part of the subject might have been partly or wholly responsible for the mean value of the frequency distribution being significantly different from zero. The object of this experiment was, therefore, to discover to what extent practice affects a second measurement and at the same time to show the variation obtained by one operator when measuring two consecutive audiograms of the same subject.

The method, audiometer and testing booth used were the same as in system (A) described in Experiment I. The operator selected for making the measurements was operator "O_A" of the previous experiment. It was thought that by using a fully experienced operator there would be less variation on the part of the operator, and, therefore, a more reliable measurement of practice effect might be obtained.

When measuring the audiograms of the subjects, the following routine was adopted. The subject sat in the testing booth and his hearing loss for the seven test frequencies was measured, first on one ear and then on the other. After a time interval of approximately one hour,

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the subject returned to the booth and the complete series of measurements was repeated exactly as before

TABLE 7

Case No	Clinical type of Deafness	Aetiology	Case No	Clinical type of Deafness	Aetiology
1	Perception	Scarred T M Rt	16	Conduction	Otosclerosis
2	Conduction	Inactive C S O M	17	Conduction	Inactive C S O M
3	Conduction	Inactive C S O M	18	Mixed	Not known
		Perforation T M			
4	Normal	Inactive C S O M	19	Normal	Eustachian Insufficiency
5	Conduction	Otosclerosis	20	Mixed	Not known
6	Conduction	Otosclerosis	21	Conduction	Inactive C S O M
7	Perception	Aviation noise deafness	22	Perception	Bomb explosion
8	Conduction	Otosclerosis	23	Mixed	Not known
9	Normal	Eustachian Insufficiency	24	Conduction	Otitic barotrauma
10	Conduction	Exudative Otitis Media	25	Conduction	Inactive C S O M
11	Conduction	Inactive C S O M	26	Conduction	Inactive C S O M
12	Perception	Bomb explosion	27	Normal	Eustachian Insufficiency
13	Conduction	Inactive C S O M	28	Conduction	Otosclerosis
14	Perception	Aviation noise	29	Conduction	Inactive C S O M
15	Perception	Not known	30	Conduction	Inactive C S O M

In an experiment of this kind it is very difficult for the operator, when carrying out the second test, not to be influenced to some degree by the results of the first test. An attempt to overcome this was made by the operator measuring the audiograms of five subjects one after the other and then re-testing them in the same order as before. By this means four different audiograms were obtained before a repeat measurement on the first subject took place. Also the results of the first and second tests were recorded on separate cards and no comparison between any two sets of audiograms was made until the total number of subjects had been tested.

4A SUBJECTS

The same number of subjects as before, drawn from a similar population, was used and Table 7 shows a clinical diagnosis together with the type of deafness for each one. This time the number of subjects in each class was

(a)	Perception deafness	..	..	6
(b)	Conduction deafness	..	..	17
(c)	Mixed deafness	..	..	3
(d)	Normal hearing	..	..	4

It will be observed that the numbers occurring in each group are similar to those used in the other experiments

TABLE 8.

Subject.		HEARING LOSS IN DECIBELS.													
		128 CPS.		256 CPS.		512 CPS.		1024 CPS.		2048 CPS.		4096 CPS.		8192 CPS.	
		X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y
1	Right Ear	30	30	30	25	30	25	30	30	30	30	30	25	25	25
	Left Ear	25	15	20	10	15	10	5	5	10	5	10	5	35	25
2	Right Ear	35	25	25	20	20	15	20	15	5	10	15	15	5	15
	Left Ear	30	30	15	15	5	10	15	20	5	5	10	10	10	15
3	Right Ear	20	5	10	5	10	5	10	10	5	0	0	5	0	0
	Left Ear	50	50	50	50	40	40	25	25	15	10	25	30	0	15
4	Right Ear	10	10	10	10	10	10	10	10	0	0	5	5	0	15
	Left Ear	15	10	15	10	10	10	10	15	5	10	5	10	5	5
5	Right Ear	35	30	40	35	40	35	35	35	15	20	15	10	30	35
	Left Ear	45	40	50	50	45	50	40	45	45	40	30	30	35	35
6	Right Ear	45	40	40	35	30	30	40	40	30	30	30	25	30	35
	Left Ear	45	45	35	45	40	35	35	40	35	25	40	35	35	20
7	Right Ear	15	15	10	10	5	5	5	10	5	5	70	75	50	65
	Left Ear	5	10	10	10	5	5	5	10	0	0	40	40	55	60
8	Right Ear	35	40	35	45	45	45	40	40	30	30	15	25	35	30
	Left Ear	35	40	45	40	50	45	40	40	25	30	25	30	35	35
9	Right Ear	15	15	15	15	10	5	10	10	0	0	0	5	5	0
	Left Ear	15	15	10	15	10	5	10	10	0	0	0	0	5	0
10	Right Ear	15	20	15	25	30	25	30	30	20	20	40	35	30	45
	Left Ear	10	15	10	10	5	10	10	10	0	0	45	50	20	15
11	Right Ear	10	10	10	10	5	5	10	10	0	0	0	0	10	5
	Left Ear	50	50	45	50	45	45	35	35	20	20	20	15	15	25
12	Right Ear	25	30	25	35	20	25	40	45	25	20	95	95	N.R.	N.R.
	Left Ear	25	25	25	35	30	40	15	25	20	20	95	90	N.R.	N.R.
13	Right Ear	25	20	20	20	20	20	25	25	10	10	10	5	35	25
	Left Ear	20	15	10	20	15	10	25	20	10	10	5	5	5	5
14	Right Ear	20	20	20	20	20	20	25	30	20	20	10	10	35	30
	Left Ear	25	20	30	25	35	30	25	30	20	15	20	15	45	40
15	Right Ear	35	45	30	40	30	40	35	40	30	45	25	35	45	60
	Left Ear	50	40	45	45	40	45	40	50	45	50	55	60	55	65
16	Right Ear	55	55	55	55	50	50	40	50	40	45	35	35	30	30
	Left Ear	35	45	40	45	30	45	40	40	20	20	15	10	10	10
17	Right Ear	35	35	40	45	30	25	25	15	5	5	5	10	35	30
	Left Ear	35	20	15	15	10	15	15	10	15	0	15	5	5	0
18	Right Ear	40	30	35	30	25	20	30	10	20	10	30	25	30	20
	Left Ear	25	30	15	15	10	5	20	15	0	0	10	10	5	20
19	Right Ear	25	10	10	15	10	10	5	5	10	10	5	5	15	10
	Left Ear	25	20	15	20	10	10	10	10	5	0	5	10	5	5
20	Right Ear	10	15	15	15	10	15	15	20	10	5	30	20	20	15
	Left Ear	40	30	35	30	30	35	15	15	15	15	30	30	30	30
21	Right Ear	15	10	15	15	20	20	25	35	20	20	15	15	25	35
	Left Ear	5	5	0	5	5	5	0	0	0	0	0	0	0	0
22	Right Ear	15	15	15	15	15	20	15	25	20	20	30	25	30	35
	Left Ear	20	15	25	15	25	25	35	15	25	20	25	30	25	35
23	Right Ear	25	20	25	25	30	25	30	25	30	15	35	30	35	30
	Left Ear	20	15	20	20	20	20	25	20	20	15	15	10	15	15
24	Right Ear	35	30	35	35	35	35	35	35	15	15	15	20	10	10
	Left Ear	10	5	10	10	5	5	5	5	0	0	0	0	0	0
25	Right Ear	20	15	25	15	20	15	10	10	0	0	25	15	25	15
	Left Ear	5	5	5	5	5	5	10	5	5	0	5	10	0	0
26	Right Ear	0	5	5	10	5	5	0	0	0	0	10	0	10	5
	Left Ear	10	25	25	20	25	20	15	15	15	10	30	20	20	20
27	Right Ear	5	5	10	10	10	10	5	0	10	5	10	10	5	5
	Left Ear	10	5	10	10	5	5	10	0	5	0	10	5	5	5
28	Right Ear	30	30	30	35	35	35	35	35	25	25	20	25	70	70
	Left Ear	45	45	45	55	50	50	45	40	35	30	45	30	45	25
29	Right Ear	20	20	25	30	30	35	25	35	20	20	25	25	25	25
	Left Ear	25	25	30	25	30	30	20	25	10	10	25	35	50	45
30	Right Ear	25	20	20	20	20	20	20	20	10	10	15	20	20	20
	Left Ear	20	15	25	20	20	15	15	10	10	5	10	10	5	5

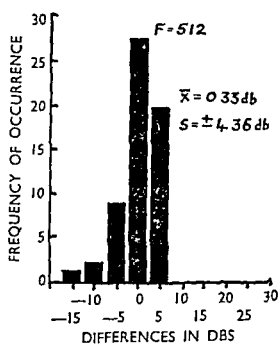
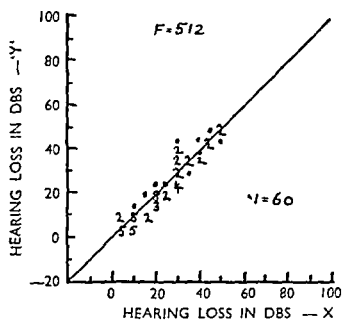
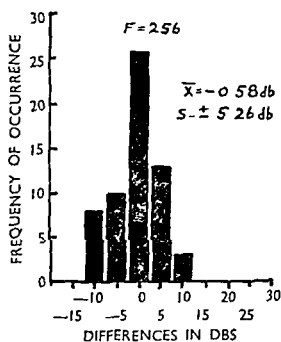
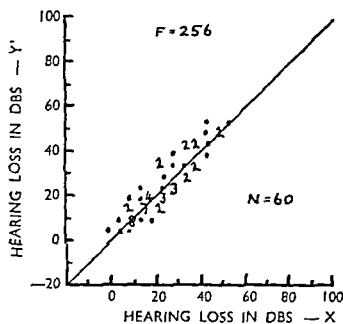
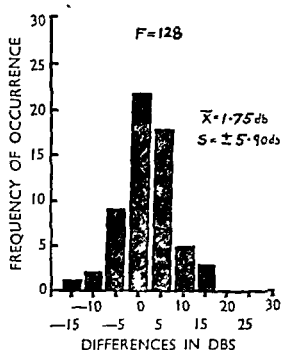
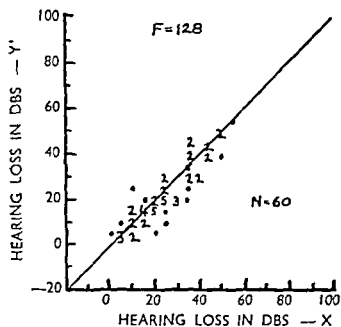


FIG 7a

R. E. C. Brown

TABLE 9.

Frequency c.p.s.	No. of Results (N)	Mean Value (X)	Standard Error (X)	Standard Deviation (S)	Range of Distri- bution	Result of "t" test
128	60	1.75	± 0.86	± 5.90	30	N.S.
256	60	-0.58	± 0.68	± 5.26	20	N.S.
512	60	0.33	± 0.56	± 4.36	20	N.S.
1024	60	-0.25	± 0.75	± 5.82	30	N.S.
2048	60	0.91	± 0.58	± 4.5	30	N.S.
4096	60	0.66	± 0.90	± 5.36	25	N.S.
8192	58	0.00	± 0.95	± 7.1	35	N.S.

N.S. = Not Significant.

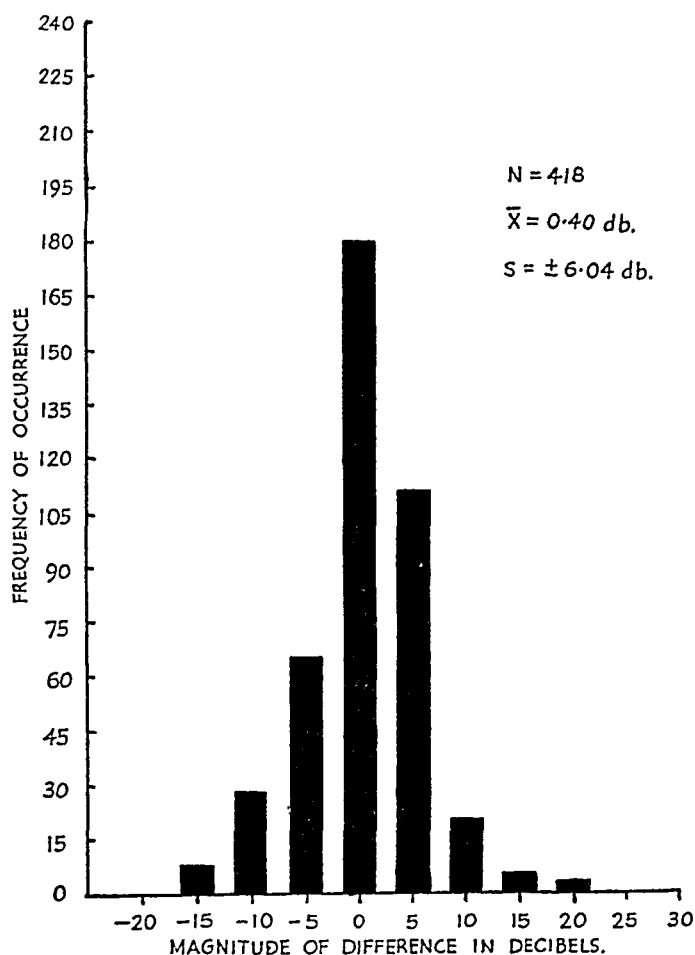


FIG. 8.

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Table 9 lists the statistical data for the histogram. The mean values of the differences for the seven distributions are not significantly different from zero and this indicates that no improvement took place on the second attempt for any of the test frequencies.

In the same manner as before, the individual histograms have been combined to form one complete frequency distribution representing all the differences and this is shown in Fig. 8. The mean value of the distribution X is 0.40 db and its standard deviation is ± 6.04 db. Although the mean value is positive, which is what one would expect if the effect of practice is to lower the threshold, it is not large enough to be significantly different from zero.

It appears then from the results of this experiment that practice effect does not improve a second measurement. It may seem at first sight that this is rather a surprising result. But it must be remembered that, in all, fourteen judgments had already been made by each person before commencing the second test. Assuming that the frequency of the testing tone had no effect on a judgment then it is not surprising to find that no marked improvement takes place on the second measurement. The correlation chart for this experiment is given in Fig. 9.

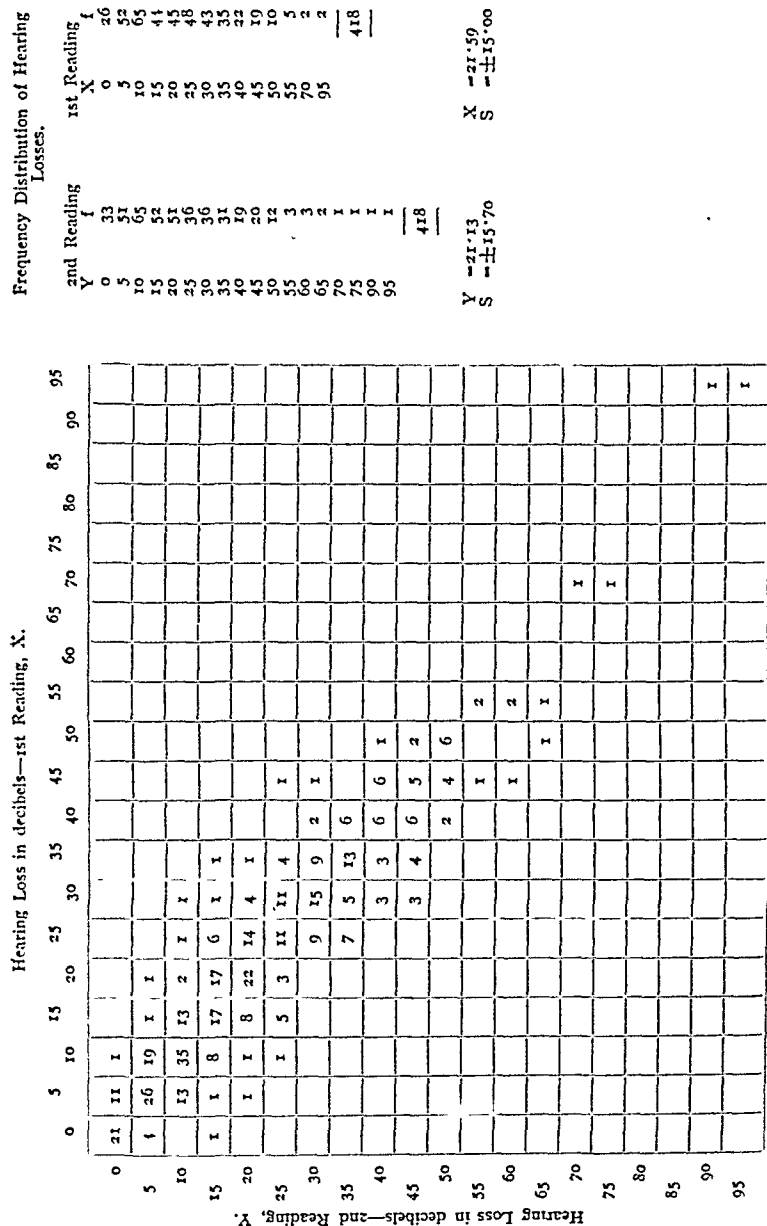
It will be remembered that in the experiment dealing with the operators it was shown that there was no difference between results obtained by the two operators. Further information on this point is provided by this experiment. If both operators are equally reliable, then the agreement between test—retest for two operators, should be of the same order as the agreement between test—retest by one of the operators. That this is true can be seen by comparing the correlation coefficients of this and the previous experiment. It will be seen from Figs. 5 and 9, that the value of " r " in both cases is the same. Again, if practice effect is negligible then the mean value of the two grouped histograms should also be the same. A comparison of Figs. 6 and 8 shows that the values are approximately equal.

Now the testing conditions for this experiment are similar to those existing when a patient regularly attends an otologist and has his hearing tested by the same measuring system each time. Therefore, assuming the patient's hearing has not changed, then the variations between successive measurements obtained in this experiment will serve as an indication of the variations to be expected by the otologist when he carries out repeat measurements.

Experiment IV

5 CALIBRATION OF AUDIOMETERS

The purpose of this experiment was to check the threshold calibration of the two machines and to discover by how much they differed. The best method of doing this was to measure the threshold of a single group



Standard Error of $r = \pm .005$

FIGURE 9.

Experimental Studies on Reliability of Audiometry

of young people on the two audiometers. Unfortunately, practical difficulties prevented the adoption of this method, and therefore a different group of subjects was used for each audiometer. For Audiometer "A" a group of 35 young people was tested whose mean age was 21 years. The group for Audiometer "B" consisted of 27 subjects whose mean age was 24 years. The hearing of all subjects was normal as far as could be ascertained by tests other than by using an audiometer.

The subjects used were medical students from the Middlesex Hospital, who volunteered to take part in the test. It was not possible in this case to use Air Force personnel for the measurements since a high percentage would have been members of aircrew who had probably spent a considerable time in high intensity noise fields such as occur in aircraft during flight. It was, therefore, possible that they might have had some degree of hearing loss which rendered them unsuitable for the test.

Each student who came to be tested was given a clinical examination by the E N T Specialist. If, after making his examination, the specialist was satisfied that there was no obvious reason why the subject should not have a normal threshold response he was passed as a suitable subject for the test.

The method of obtaining the audiogram was the same as before and each audiometer was used under the same testing conditions.

5A RESULTS

Fig 10 shows the distributions of the hearing loss for each frequency and the mean value \bar{X} of each distribution has been taken as the figure for comparison with the zero reading on the dial of the audiometer. It will be seen that for Audiometer "B", with the exception of one frequency the mean values of the separate distributions were within 5 db of the indicated zero, but for machine 'A', three frequencies show a mean greater than 5 db. The mean values of the distributions and the differences between them are shown in Table 10.

TABLE 10

Frequency cps	\bar{X}_A	\bar{X}_B	$\bar{X}_A - \bar{X}_B$
128	2.71	4.40	-1.69
256	5.61	6.20	-0.59
512	4.71	4.30	0.41
1024	1.07	3.30	-2.23
2048	-0.21	2.60	-2.81
4096	7.85	4.50	3.35
8192	7.50	0.6	6.90

The results of this experiment show that there was a difference in the calibration of the two audiometers at some frequencies but there is not

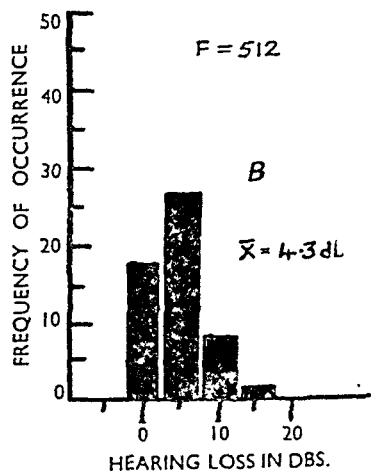
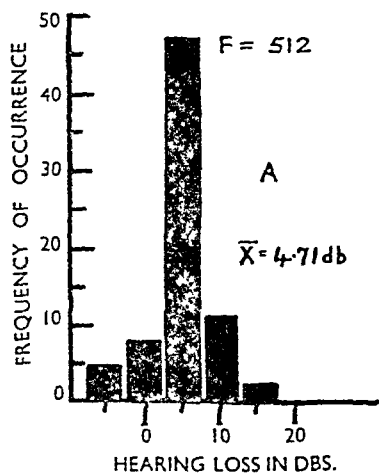
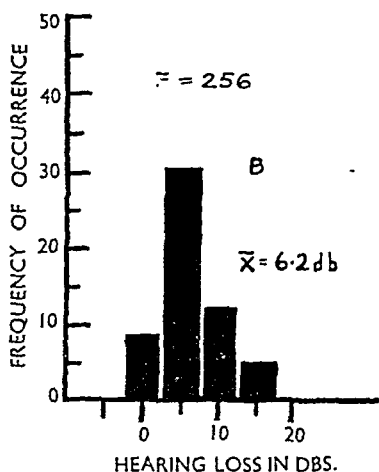
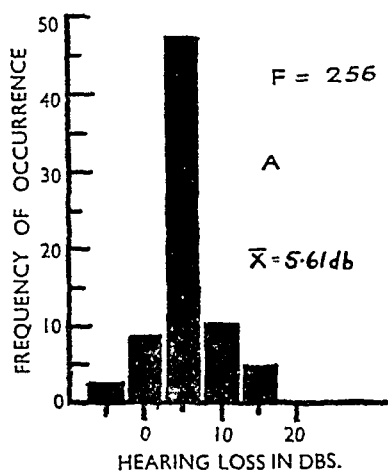
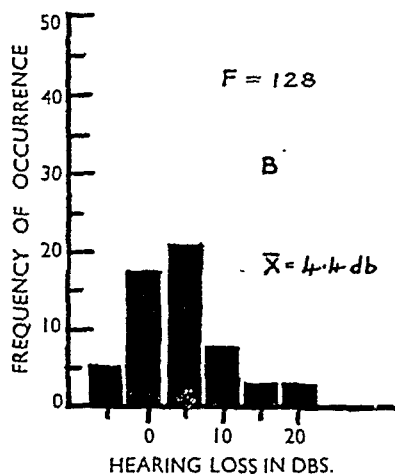
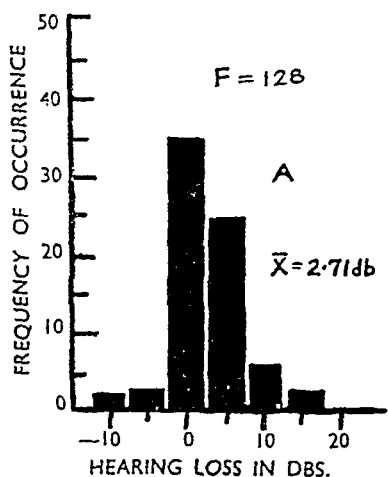


FIG. 10a.

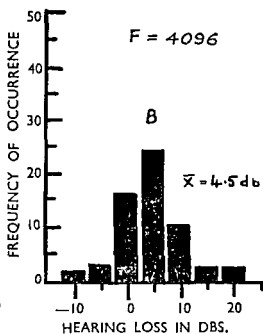
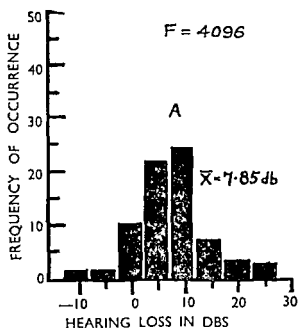
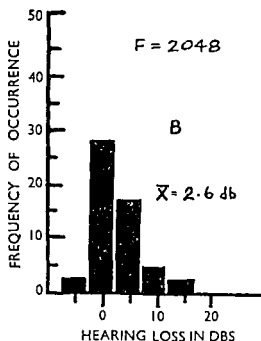
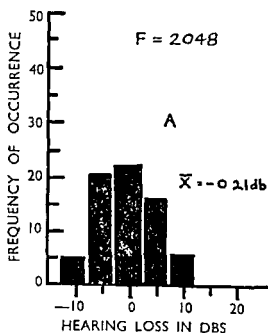
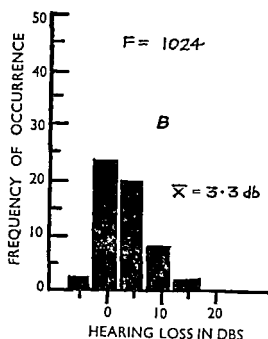
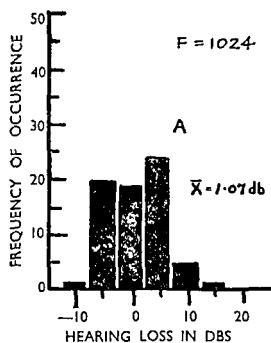


FIG. 10b.

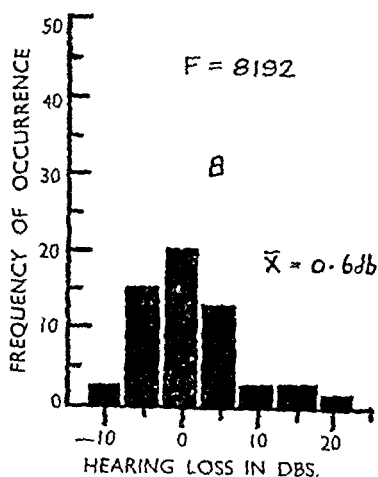
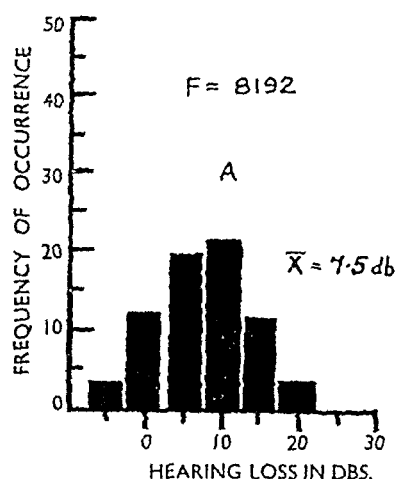


FIG. 10C.

sufficient evidence to show that these differences are entirely responsible for the consistent difference which appears in the results of Experiment I. It is clear, however, that the magnitude of the differences between the measurements obtained from the two machines is greater than that of the differences established in Experiments II and III.

As a matter of interest a grouped histogram was made of the hearing losses for the separate frequency distributions of Audiometer "A". The standard deviation for this histogram was found to be $\pm 5.85 \text{ db}$. This shows that the scatter of the hearing losses for the normal subjects was of the same order as the scatter of the differences between the results of the previous experiments.

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SUMMARY OF RESULTS

It has been shown that, when a group of subjects had their hearing losses tested first on one system and then on another one which was very similar the agreement between the two sets of measurements was extremely high, the correlation coefficient being 0.921. For all the differences obtained the mean value was 4.58 db and the scatter of the differences relative to the mean in terms of the standard deviation (S) was ± 7.48 db. If the variations obtained by using the two similar systems is representative of what is likely to occur in practice then differences between measurements at any frequency falling within the range of ± 15 db can be expected to occur and should not be taken as a reliable indication that a subject's hearing has changed. Therefore, in order to be able to say with a fair degree of certainty that a change in a subject's hearing has taken place, differences greater than ± 15 db should occur between measurements. This, of course, assumes that no change takes place in the testing conditions and that the calibration of the two audiometers does not differ at any time.

When, however, measurements were repeated on the same system, the agreement between the results improved as shown by the fact that the correlation coefficient increased to 0.95. The mean value of the differences in this case was -0.34 db and the standard deviation was ± 6.1 db. So working to the nearest unit of 5 db then, in these circumstances, differences greater than ± 10 db should occur between measurements at any frequency before they can be taken to indicate a change in the subject's hearing.

With the exception of the first experiment, the measurements at each frequency were found to be equally reliable when a background noise of intensity level 40-50 db above the standard level was present in the testing booth. This does not necessarily mean to say that each of the tones at threshold level was equally easy to hear but rather that no one frequency produced results which showed better agreement than another.

When two operators, using different techniques but the same method of determining threshold, each tested the hearing of the same group of subjects no significant difference between the results could be found. From a knowledge of the experience of audiometry possessed by each operator and the results obtained, it has been shown that a person with no previous experience of audiometry may become reliable in the measurement of audiograms after testing about 30 subjects.

No improvement could be found in the hearing losses for a group of subjects when the audiograms were repeated under the same conditions. This shows that the effect of practice on the part of the subject did not produce a lower value of hearing loss. Of course, it does not follow that, in individual cases, a second test on a patient will not show a different result from that of the first, since it is quite likely to occur in practice that

sufficient care has not been taken by the operator in ensuring that the patient is completely familiar with the test before making any measurements. Again, difficulty may be experienced when dealing with very deaf people or children whose hearing is being tested for the first time and successive measurements may show improvement. But, in general, if the test is properly given, it can be said that no reliable improvement takes place on a second measurement.

When checking the threshold calibrations of the two audiometers it was found that the dial readings differed slightly from the true value. Taking the zero reading on the hearing loss dial as the figure for comparison then the maximum error from the indicated zero occurring at any one of the octave frequencies 128-8192 c.p.s. was 7.85 db. for one of the machines and 6.2 db. for the other.

The author wishes to thank Dr. D. B. Fry, University College, London and Mr. G. E. Swindell, Marischal College, Aberdeen for their many valuable suggestions in the preparation of this report.

METASTATIC BRAIN ABSCESES AND ENCEPHALITIS OF OTITIC ORIGIN

By P G GERLINGS (Amsterdam)*

METASTATIC brain abscesses can exceptionally be found in cases of inflammatory processes of the ear Up to 1939 about 30 cases have been published in literature (Seeburg)

Etiology As a rule metastatic brain abscesses develop as a complication of a lateral sinus phlebitis following up an acute or chronic otitis media Thus they are often combined with metastases in other organs lung, spleen, liver and kidney In some cases the metastases are confined to the brain (Fruhwald) In cases, in which the sinus transversus and other dural sinuses were not affected, Körner supposed an osteophlebitic pyæmia to be present

Pathology The abscesses are an exception to the rule of Körner that brain abscesses, originating from the temporal bone, are found in the neighbourhood of the primary focus Predilection for a certain localization does not exist These abscesses are found as well in the temporal lobe (Fruhwald), parietal lobe (Brieger), frontal lobe (Bondy, Forselles), occipital lobe (Hofer) as in the cerebellum (Lund, Behlau, Meurmann) and in the basal ganglia (Schwartz, Calicetti, Forselles) Multiple abscesses were also seen (Urbantschitsch, Krepuschka, Hofstr)

A group apart is formed by the brain abscesses caused by a thrombosis of the vein of Trolard (and Vv fossæ Sylvii) in which an abscess in the motoric cerebral cortex develops (Hegener) or along the venæ cerebri inf, after which an abscess in the cerebellum can be found Marx mentions a case in which the infection reached the basal ganglia and the internal capsule To this group also partly belong the otogenic frontal lobe abscesses described by Courville and Nielsen

Frequency In 61 brain abscesses Lund found once and in 40 brain abscesses Meurmann three times a metastatic brain abscess In 139 cases of sepsis after otogenic sinus thrombosis Fruhwald found 5 metastatic brain abscesses

Symptomatology The symptoms of the metastatically developing brain abscess do not differ from those generally caused by a brain abscess The well known paucity of symptoms was reason that often an abscess was not found before the autopsy

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P. G. Gerlings

Especially in those cases in which crossed focal symptoms are present, the explanation of the symptoms may cause difficulties especially when the clinical picture of the otogenic pyemia is no longer present.

Generally it can be said that focal symptoms do not belong to the picture of the otogenic sinus phlebitis.

Diagnosis. In difficult cases neuro-surgical assistance cannot be dispensed with (ventriculography, exploration).

Crossed focal symptoms in metastatic brain abscesses were seen a.o. by Forselles. Some other clinical pictures can give the same symptoms (pseudo brain abscess, Adson) :

a. Otogenic encephalitis (see Case III).

b. Diffuse cerebral circulatory disorders. At the autopsy of some cases of lateral sinus phlebitis with typical crossed focal symptoms Haymann found only slight disorders, mainly venous thrombosis of the crossed side. Closely allied are the symptoms' in cases of otogenic hydrocephalus (Symonds, Bourgeois, Asherson).

c. Otogenic meningo-encephalitis collateralis. From the group of pseudo brain abscesses Ramadier separated a certain clinical picture which he described as "otogenic meningo-encephalitis collateralis" and which is characterized by :

1. The extensiveness of the focal process ; notwithstanding the short duration of the disease ;
2. The transitory course ;
3. Often crossed focal symptoms.

The cause of the focal symptoms is cast about for in a collateral inflammation or oedema of the brain in otogenic meningitis. The latter may, in certain cases, occur simultaneously with a lateral sinus phlebitis.

Brunner pointed to the fact that the most frequent form of aphasia, the amnesic one, is not certainly due to a suppuration in the temporal lobe. Already Körner knew that otogenic meningitis is sometimes running the course of a focal process so that one is apt to suppose a brain abscess with secondary meningitis. The symptoms of the lepto-meningitis are in no small measure dependent on the localization of the inflammatory process which may also cause a contralateral localization.

Prognosis. None of the cases, published in literature, recovered.

Therapy. The improvement of the neurological diagnosis and of the neuro-surgery, together with the administration of the newer chemotherapeutics and antibiotics, justify an expectation of better future results.

The following cases were observed in our clinic.

CASE I.

Girl, aged 9 years. During the last 3 years discharge from left ear, slightly foetid. Now and then pain in the ear, treated with red lamp-radiation in spring 1936. End of August 1936, patient had a fall from a bicycle after which she



FIG 1

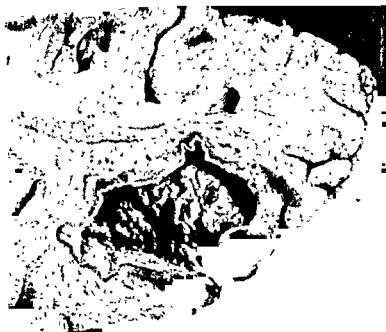


FIG 2



FIG. 3



FIG. 4

Metastatic Brain Abscesses

was drowsy. No vomiting, three weeks before admission pain in left ear with fever, one week thereafter headache above left eye. Temperature dropped. When there was pain, patient was somewhat dull, sometimes she complained of double vision, sometimes she could not think of the names of persons and things. Eight days ago the headache became suddenly worse, also pain in left back of the head. Dr. Roozendaal, called in consultation, advised admittance to the Municipal Hospital, Zaandam. On December 10th, he performed a radical mastoidectomy on the left side (forward position of the sigmoid sinus, dura of middle cranial fossa was exposed, normal). Temperature remained high, at night patient was disordered, headache (diplopia).

Examination on December 14th (Department Professor Brouwer). Patient is severely ill, pale, emaciated. Pulse 134, temperature 103.3. Heart and lungs normal. Patient is righthanded. Neck stiffness, pronounced symptom of Kernig on the left, indicated on the right. Visus $\frac{3}{4}$ on both sides. Fundi: on both sides the nasal side of the papilla is somewhat raised, surroundings vague, vessels too much twisted. Fields of vision: right-sided homonymous hemianopsy. Slight abducens paresis on the right. Cornea reflexes present on both sides. Blood picture: 19,850 white blood cells, 14½ per cent. stab cells; anæmia; hæmoglobin 56 per cent. Finger to nose not as well executed on the left as on the right. No spontaneous past-pointing. No dysdiadochokinesis, no dysmetria. Biceps- triceps- and tendon reflexes +, L=R. Abdominal reflexes low, R<L. Knee tendon reflex +, R=L; Achilles tendon reflexes +, R>L, Strümpell on both sides, Rossolimo R=L, Bechterew R=L. Motility no disorders. Sensitiveness: hyperæsthesia for pain on the whole body, L<R. Complete sensory and amnesic aphasia without ataxia, with a tendency to perseveration of words. Diagnosis: otogenic brain abscess, encapsulated, in left temporal lobe.

December 12th. Brain puncture in temporal lobe negative. After the operation continuous intermittent fever up to 104° and above.

December 20th. Far behind the mastoid wound a tender fluctuating swelling has developed; on incision much pus (Gram-positive coccus, culture negative).

December 31st. From the incision-opening (December 20th) still pus. Operation: a large opening is made. In bone round opening from which some pus. The bone is necrotic. On nibbling, suddenly much pus, ± 100 c.c., yellow-green, thin. There is an abscess-cavity occipitally, just above the tentorium cerebelli (culture: pneumococcus and staphylococcus).

January 1st. In the lower posterior part of the left lung infiltration with pleuritis.

January 5th. Since some days condition is deteriorating, pulse bad, pronounced dyspnœa, high temperature, disordered. Expired.

Autopsy. (Professor Deelman.)

Thrombosis sinus transversus, leptomeningitis, abscessus cerebri, pleuritis sero-fibrinosa, abscessus pulmonum, pneumonia lobularis duplex.

Brain Autopsy.

Behind left ear granulating cleaned wound of mastoid operation. More occipitally-ward in occipital bone there is a gap with a diameter of 1: the edges of the hiatus are nibbled and necrotic. Here the dura is $\frac{1}{2}$ mm

P. G. Gerlings

discoloured, adherent to the surface of the brain which are fluctuating. For the rest bilaterally equal not very firm elastic consistency. On cutting, in the sinus transversus, beside a yellow-red lardy coagulation on the foreside a parietal piece of thrombus of about 2 cm., bordering on the posterior wall of the os petrosum (Fig. 1). Examination after fixation: under the dura, which is attached to the surface of the brain, an abscess-cavity of the size of a walnut is seen with very thin, scarcely identifiable fibrous wall and greenish contents (Fig. 2).

Epicrisis Case I.

A girl, 9 years of age, was operated upon elsewhere because of a chronic otitis media on the left and acute exacerbation. Hereafter temperature remained high, slight meningeal symptoms developed, right-sided homonymous hemianopsia and a complete sensory and amnesic aphasia. Puncture of the temporal lobe as well as of the sinus transversus were negative. On re-operation, three weeks after the first one, a brain-abscess in the occipital lobe was found with local osteomyelitis of the bone. At the autopsy a small parietal thrombus in the sinus transversus proved to be the cause.

CASE II.

Girl, aged 7 years. April 1941, earache and high temperature. The right tympanic membrane was red, after some days a swelling behind the ear developed, after incision much discharge of pus. Temperature, however, remained septic so that a mastoid operation was performed. Recovery, however, did not make progress.

On July 6th, patient became delirious. No headache, not sick, no vomiting. Pulse rate 109. Distinct sensory and amnesic aphasia. Abdominal reflexes on the right absent, on the left present $R > L$. Knee tendon- and Achilles tendon reflexes bilaterally symmetric. No pathological foot-sole reflexes, no hemianopsia. Periosteal reflexes of the arms: on the right somewhat higher than on the left. Tendon reflexes on the arms bilaterally similar. Fundi oculi: acute engorgement with hæmorrhage and exudate. Conclusion (Professor Brouwer): left-sided temporal focus.

July 9th. Examination of the ear. Tympanic membranes bilaterally normal. Whispering voice, right ear 2 metres, left ear 6 metres. Vestibular examination: no spontaneous nystagmus, no position nystagmus; with cold and warm water left labyrinth can easily be stimulated. Röntgenological examination: fairly pronounced pneumatization, cells clear, on the right still some blurred cells, the cranial sutures are much widened, the right temporal bone is very thin. Pressure right ventricle 420 mm., the left ventricle cannot be found. Ventriculography: after removal of 20 c.c. of liquor and blowing in of 15 c.c. of air on the right occipitally; the third ventricle also contains air, the whole is displaced to the right. The air does not pass to the left. Spinal fluid: Nonne —, Pandy \pm . Cell count:

8 polymorph. nuclears + 1 lymphoc.

3

July 12th. Distinct facial paralysis on the right, slight paresis right arm, temperature 102.6.

July 15th. Operation (Dr. Lenshoek). Behind the left ear and above the

Metastatic Brain Abscesses

mastoid a bore-hole is made On puncture posteriorly upward at ± 4 cm a capsule is felt and after boring yellow green pus excretes Total amount 15 c c (Pneumococcus mucosus) Injection of 5 c c of thorotrast *Left sided parieto occipital abscess, diameter ± 4 cm*

July 21st A swelling with fluctuation develops on the head, somewhat behind the bregma Incision there was exposure of the bone, no communication with mastoid wound

July 25th Administration of prontosil Temperature normal

July 28th The right sided paresis becomes more pronounced

July 31st Patient is dull, complains of headache Bore hole made near the abscess is enlarged to the extent of a guilder Incision of dura After puncture pus spouts out Between dura and bone vioform-tampons with iodide in order to cause adhesion

August 2nd Outer wall abscess removed The lower side of the abscess membrane raises to the level of the bone

August 16th Fistal in old mastoid scar on the right, 2 cm behind which a thickening of the skin, very tender on pressure From the fistal much pus Auditory meatus dry Area under tip of the mastoid slightly swollen

Operation (Professor De Kleyn) Previous mastoid cavity is filled with grey granulations and some pus Transversal incision backwards Between the tip of mastoid and the skin is a membrane, probably obstructing the mastoid cavity After removal of the membrane a large pocket is found, penetrating between the jugular muscles about 4.5 cm (mastoiditis of Bezold) Tip of mastoid is much impaired, bone soft, cells filled with pale granulations Culture from the pus of mastoid and neck abscess Pneumococcus mucosus

August 25th Temperature 101.3 No longer pus in abscess cavity

August 28th Since yesterday general condition deteriorating Temperature 102.2 The child is drowsy and paler Distinct hemiparesis on the right, pronounced aphatic disturbance of speech Probably no hemioanopsia Fundi oculi bilaterally white papilla, edge somewhat unsharp No distinct difference in level

September 18th Brain hernia has markedly increased Puncture 20 c c green pus, 3 c c thorotrast X-ray picture temporally a second abscess is found, extending occipitally

September 20th Pus removed, 15 c c

September 21st Notwithstanding repeated puncture general condition worse

October 1st Expired

Autopsy (Professor Deelman)

Otitis media on the right, brain abscess on the left, osteomyelitis of the cranial roof

Brain Autopsy

In the cranial roof at the place of the scars and the brain hernia, an opening of the size of a guilder In the centre of the cranial roof above the sinus sagittalis defect of bone with irregular edge (osteomyelitis) On the back head ventricle puncture bore openings The dura is smoothly braced sagittal sinus and lateral sinus are completely obliterated, from the sagittal sinus yellowish green thick discharge Subarachnoidally much thin clear

fluid. The left parieto-temporal lobe is wider than the right one. The gyri are markedly flattened, sulci narrow. The temporal lobe feels fluctuating. Pressure-resorption of the lamina cribrosa. Brain after fixation: deep in left hemisphere an abscess, of the size of an orange, filled with yellowish-green pus and a thick membrane of 1-2 cm. is found. Pronounced displacement. Temporally on the left a small collapsed bloody cavity (probably the first operated abscess). Beside it still three small abscesses (Fig. 3).

Epicrisis Case II.

This girl was admitted into the department of Professor Brouwer, owing to a sensory and amnesic aphasia, developing three months after a mastoiditis on the right (operation). Diagnosis: left-sided temporal focus. The latter was found by Dr. Lenshoek after ventriculography and injections of thorotrast. Re-operation on the right mastoid: a cavity filled with pus was found, penetrating into the jugular muscles. At the autopsy the lumen of the sinus transversus appeared to be obliterated completely. In the left hemisphere a large abscess, with thick membrane and very pronounced displacement was found, at the top of the hemisphere also some smaller abscesses.

CASE III.

Girl, aged 7 years, developed an earache on the right with deafness, four weeks ago during measles. Spontaneous thin yellowish discharge, which, during the last days, became thicker and green. No discharge from ear in the last two days. High temperature (104) during last two weeks. Fourteen days ago suddenly severe pain in both legs, especially in the feet and bends of the knees. Since some days thickness and redness. Since ten days, dyspnoea, some coughing, no expectoration, sometimes pain in her side and chest.

May 29th. Patient is severely ill, does not react to addressing. Strongly emaciated, anæmic, dyspnoeic, nostril-respiration. Pulse frequent, small, regular. Head and eyes turned to the left, nystagmus →L. Pupils moderately wide, equal, round, react to light. Sometimes spasmodic contraction of the left part of the face, whereas the right part is quiet (facial paresis). Lungs: dullness in lower lobes, with moist small vesicular râles.

Heart, no disorders, abdominal reflexes bilaterally present but lower on the right. Right arm and leg are constantly drawn up, but can be straightened, although with resistance. When the head is turned to the left, the right arm becomes supple, the right leg moderate, the left arm tonic. Knee tendon and Achilles tendon reflexes +, R=L. Strümpell reflex +, R. and L. Right knee is swollen and red, right foot reddish-blue discoloured, especially the foot-sole. Urine: trace albumen, sugar negative, sediment many erythrocytes and leucocytes. Blood picture: hæmoglobin 55 per cent., red blood cells 2,960,000. White blood cells 16,900. Spinal fluid: pressure 150 mm., respiratory and pulse pulsations positive, cell count

628 polymorph. nuclears + 48 lymph.

3

Right ear, large central perforation, moderate non-fœtid discharge. Left ear, tympanic membrane normal, auditory status cannot be made. Caloric examination: 25 c.c., 20° A.D.: Ny→L (pronounced); 25 c.c., 20° A.S. Nyst.→R; 50 c.c., 48° A.D., no distinct horizontal nystagmus, 50 c.c., 48° A.S.: Nyst.→R (slight).

Metastatic Brain Abscesses

Internal examination: measles, encephalitis, bronchopneumonia, otitis media. Therapy: administration of cibazol.

Neurological examination (Dr. Biernond): the most outstanding features of the neurological picture are the right-sided central facial paresis, the "déviation conjuguée" and the paresis of the right leg and arm. It is striking that the patient does not speak much (aphasia). Fundi oculi: no disorders on the right, on the left it is difficult to see the fundus.

Conclusion: probably cerebral process on the left (abscess).

May 30th, 1943. The child does not say anything yet, but does sometimes act upon an order. Head is now lying straight, eyes are deviated to the left. Facial paresis on the right (central). Probably paresis of the right arm and leg, although these are still drawn up. No Babinski. Abdominal reflexes R=L. Pupils react normally, R=L. Fundi oculi on the left: scar of choroiditis; on the right: slight swelling of the papilla.

May 31st. Blood culture: hæmolytic streptococcus. Blood transfusion of 250 c.c. (blood group B).

June 1st. Condition the same. The left arm seems to be somewhat less spastic and its spontaneous movements are easier. Sedimentation rate 143/150. Polymorph. nuclears 16,200 (19 per cent. stab cells) non-toxic.

June 2nd. Right ear dry perforation, left ear tympanic membrane normal. Prontosil.

June 7th. The streptococcus is most sensitive to sulphanilamide. General condition has improved since May 31st. Blood transfusion 250 c.c.

June 8th. Only slight discharge from right ear (after removal of cerumen).

June 9th. Blood transfusion 350 c.c. Blood culture: hæmolytic streptococcus, culture from right ear negative.

June 10th. Opening of right mastoid on account of continuous high fever (notwithstanding administration of prontosil) and deterioration of general condition and of previous right-sided otitis. Until now this operation had been delayed as there was less discharge from the right ear and the general condition was very bad. An operation was also less advisable owing to a brain process on the other side. Intention was to transmit patient to the Department of Neuro-Surgery as soon as the condition permitted.

Under the corticalis a large cavity was found, filled with thick pus (mastoid culture negative). Lateral sinus lies free in this space and looks normal. Puncture of sinus: pure blood, culture negative. Blood transfusion 500 c.c.

June 11th. Expired.

Autopsy (Professor Deelman).

Status post operationem, operation wound of the mastoid-operation on the right. Pleuritis fibrinosa et fibrosa sin. Pulmonary infarct. Bronchopneumonia. Heart abscess, endocarditis acuta valvularis mitralis. Spleen and kidney infarct. *Purulent inflammation of brain substance of the left basal ganglia.*

Section of the skull: the left parietal brain hemisphere is weaker than the right one. All sinuses contain blood or are empty. Gyri and sulci normal. Pial vessels markedly injected. Brain after fixation: in the frontal section, centrally in the left hemisphere, a focus of necrosis, probably already with formation of pus and severe collateral inflammation (hyperæmia and

hæmorrhages). The necrosis is strikingly settled in the basal ganglia. The whole is at least of the size of an egg (Fig. 4). Microscopical examination: marked delay of specific nervous tissue. Diffuse infiltration with inflammatory cells, especially leucocytes. Hyperæmia and cellous infiltration, also lipophages around the necrosis. No development of an abscess. Epithelium of ventricle intact.

Microscopy right temporal bone: chronic inflammation of middle ear with large perforation of tympanic membrane. Infiltration and formation of connective tissue in middle ear, also around stapes and niche of round window. Some large paralabyrinthine cells, proceeding towards the internal auditory meatus.

Epicrisis Case III.

This girl developed a middle-ear inflammation on the right with high fever after measles. Besides meningeal symptoms a right-sided central facial paresis was found with "déviation conjuguée", paresis of right arm and leg, which was suggestive of a brain abscess on the left. In the blood culture hæmolytic streptococcus, i.e., sepsis. On mastoid operation on the right a large cavity with thick pus is found, in which the sinus, containing blood, lies exposed. At the autopsy no thrombus in lateral sinus. Lungs, spleen and kidney infarct. Heart abscess and endocarditis acuta valv. mitralis. Centrally in left hemisphere (especially basal ganglia) focus of necrosis with severe collateral inflammation. No development of abscess. The possibility exists that the heart abscess proceeded from the ear, by which also the endocardium was affected and that to this heart abscess the metastases in the body were due. A second possibility is an osteophlebitis pyæmia according to Körner.

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A NOTE ON THE ARTICULATIONS OF THE AUDITORY OSSICLES AND RELATED STRUCTURES

By D V DAVIES (Cambridge)

MOST anatomical and physiological textbooks dismiss the articulations between the auditory ossicles with very brief and incomplete descriptions. The majority, however, note that the base of the stapes is connected to the margins of the fenestra ovalis or vestibuli by a ring of elastic tissue. An accurate description of this joint has been given by Toynbee and a further excellent account can be found in Stricker's book on *Human and Comparative Histology*. Helmholtz devotes considerable space to the articulations of the auditory ossicles, describes the surfaces in detail but makes only brief reference to the capsule of the incudo stapedial joint as delicate and "more interwoven with elastic fibres than are the two other articulations". He also mentions the elastic fibrous cartilaginous lip surrounding the basis of the stapes. Rudinger (in Stricker's *Histology*) states that a layer of elastic fibres invests the joint between the stapes and the fenestra vestibuli whilst Testut speaking of the joint between the incus and stapes mentions "une capsule fibreuse renfermant dans son épaisseur de nombreuses fibres élastiques". Sappey refers to Duveney's description of the annular ligament of the base of the stapes as composed of radiating fibres but makes no mention of their nature. Wrightson merely states that it is probable that the fibres connecting the base of the stapes to the frame of the fenestra vestibuli may be partly elastic and partly inelastic. Retzius makes no mention of elastic fibres in these joints and no further details regarding the distribution of elastic fibres in the middle ear could be found in the literature.

In view of the lack of information on this point, four young adult human middle ears were sectioned and stained with orcein for elastic tissue. The problem of the changes in elastic tissue with age will not be discussed here.

The details given by Rudinger of the joint between the stapes and the fenestra ovalis have been verified in the main. According to him the peripheral margins of the footplate of the stapes and the margins of the fenestra vestibuli are lined by hyaline cartilage. This, however, is not quite correct as the cartilage is really a fibrocartilage of the elastic variety. Indeed Rudinger describes this cartilage as prolonged on to the whole of the vestibular surface of the stapes, being distinguishable by its

yellowish tint. The opposed surfaces of the stapes and of the fenestra vestibuli are connected by elastic fibres running through a hyaline acellular matrix within which are intercommunicating spaces, in fact a type of syndesmosis with a large quantity of hyaline interfibrillar material and elastic fibres which penetrate the cartilage on the rim of the base of the stapes and that of the fenestra vestibuli. The cavities in the hyaline matrix have led Rüdinger to regard the joint as an amphiarthrosis with multiple intercommunicating spaces instead of a single joint cavity. There are few cells in the matrix of this joint and no synovial membrane lines the cavities in it. According to Rüdinger the annular ligament of the base of the stapes is composed, both on its vestibular and tympanic aspects, mainly of elastic tissue. The elastic fibres on the tympanic aspect end within a short distance of the joint, partly by blending with the periosteum on this surface and partly by becoming lost in the connective tissue of the mucous membrane lining the middle ear. Those on the vestibular aspect are continued for some distance from the joint, particularly posteriorly, where they form the lining periosteum of the vestibule and can be traced clearly for about 1 mm., the periosteum beyond this being white fibrous tissue. At the anterior aspect of the joint the elastic periosteum of the vestibule is about 0.2 mm. wide. These fibres are continuous across the vestibular aspect of the footplate of the stapes as a compact elastic membrane, clothing the cartilage here. A few elastic fibres occur in this cartilage also (Fig. 1).

The joint between the incus and stapes is provided with a capsule composed mainly of elastic fibres as described by Testut (Fig. 2). Underlying this is a well marked synovial membrane. Even more surprising is the content of elastic tissue in and around the tendon of the stapedius muscle (Fig. 3). These elastic fibres form more than a third of the whole tendon and are particularly numerous around its periphery although an abundance of elastic fibres can also be seen even amongst the white fibres of the tendon bundles. These elastic fibres have various origins posteriorly. Some seem to arise in continuity with muscle and tendon fibres. Others are attached to the periosteum lining the central canal of the pyramid, whilst still others are continued posteriorly into the stroma of the mucous membrane at the mouth of the pyramid.

The posterior ligament of the incus is composed mainly of white fibrous tissue but has a small bundle of elastic fibres running along its surface.

Like the incudo-stapedial joint, that between the malleus and incus is of the diarthrodial variety and presents a well marked synovial membrane. Its capsule, like that of the former joint, is composed mainly of elastic tissue (Fig. 4). Similarly the tendon of tensor tympani is as rich in elastic fibres as that of the stapedius muscle, these arising both

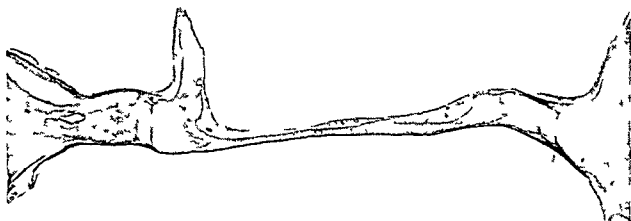


FIG 1

Section across the foramen ovale and the footplate of the stapes showing the elastic fibres of the annular ligament of the base of the stapes. Note that on the vestibular aspect the elastic fibres are continuous over the footplate of the stapes.

Stained with orcein and methylene blue $\times 37\frac{1}{2}$

The orcein is a true specific stain for elastic tissue which appears black in the photographs



FIG 2

Section through the incudo stapedial joint showing the capsule composed almost exclusively of elastic tissue

Stained with orcein and methylene blue $\times 56$



FIG. 3.

Transverse section of the tendon of the stapedius muscle. The dark areas are composed almost exclusively of elastic fibres.

Stained with orcein and methylene blue. $\times 56$.



FIG. 4.

Section through a part of the capsule of the joint between the malleus and incus to show the elastic fibres. This capsule is almost exclusively composed of elastic fibres.

Stained with orcein and methylene blue $\times 56$.

Articulations of the Auditory Ossicles

from the walls of the semicanal for the muscle and in continuity with its fibres, whilst a considerable number of elastic fibres seem to arise in the mucous membrane covering the processus cochleariformis

The stroma of the mucous membrane of the middle ear everywhere contains a number of elastic fibres with concentrations in the places indicated. Furthermore, it has been noted in these studies that the arteries of the middle ear are well endowed with elastic tissue, both the internal and external elastic laminae being particularly well developed for such small arteries. This is very evident in the stylomastoid branch of the posterior auricular in the canalis facialis

That elastic fibres should form such a prominent feature in the joints and tendons of the internal ear is perhaps not surprising. In regard to the joints, it is clear that as no muscles cross any of these some such mechanism must exist not only to correct any displacements but also to maintain the joint surfaces in apposition in the absence of muscular tonus. Furthermore, the elastic tissue serves the purpose of damping any vibrations of the auditory ossicles much more effectively than white fibrous tissue, the elastic fibres in the tendons of the tensor tympani and stapedius muscles, whilst serving the same purpose, also make the pull of these muscles much less sudden and translate it into a much slower and more gradual action, part of the force generated by the muscle being expended in the extension of the tendon

Small quantities of elastic tissue are known to occur in many human tendons. These are described by Smirnow, Martinotti and Gemmill. Large proportions of elastic tissue in tendons and ligaments are unusual though not unique. Miall and Greenwood, also Burns, state that about half of the fibres in the tendon of the flexor carpi radialis of the elephant are elastic, whilst Burns mentions a similar though less marked development of these fibres in another forelimb muscle, probably the flexor profundus. Miall and Greenwood also describe a large complement of elastic fibres in the ligament extending down the outer side of the "forearm" in the elephant. None of the functions attributed to these elastic tendons by the above authors would apply in the case of the stapedius. More interesting are the observations of Carlier who describes the tendon of the ciliary muscle in a large series of birds as mostly composed of elastic fibres ending on the sclera or the ora serrata. This, he states, allows for the immediate restoration of the length of the muscle when contraction ceases thus allowing more rapid accommodation. This applies equally well in the case of the stapedius and the tensor tympani

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CLINICAL RECORD

OPERATION (THYROTOMY) FOR DISTENSION CYSTS OF LARYNGEAL SACCULE

By R THOMAS (York)

Four cases of saccular distention cyst are described below. They have occurred during a period of ten years.

Case 1	Man	age 49	1940
Case 2	Man	age 71	1942
Case 3	Woman	age 66	1947
Case 4	Man	age 58	1948

The symptoms in each case were a "plum in-the throat" voice and dyspnoea, increasing over a period of months and, in Case 3, years.

Examination reveals a round, reddish tumour, filling the pyriform fossa rather than encroaching on the interior of the larynx. Quite clearly it extends upwards and obstructs the breathing only by pushing the aryepiglottic fold inwards, and by overlapping the laryngeal aperture (Fig. 1).

Examination under anaesthetic (with Davis gag and laryngoscope) shows the tumour to be soft and cystic, and occupying the upper part of the pyriform fossa. In two cases the cyst was with difficulty incised and serous fluid evacuated. The voice did not return to normal afterwards, and the cyst soon recurred. In the fourth instance, the cyst, which was smaller than in the previous cases (despite six months' history) contained thick mucoid secretion.

The third case was subject to a curious accident. A colleague performed the examination under anaesthetic. Soon after returning to the ward the patient became seriously obstructed by a sudden diffuse swelling of the tongue—so much so that the House Surgeon sought to perform an immediate tracheotomy. In his anxiety he cut through the isthmus of the thyroid cartilage, and inserted the tracheotomy tube between the cords. Fortunately he saved the life of the patient, and when my colleague had performed a correct tracheotomy an hour later, the swelling of the tongue subsided rapidly. There appeared to be no hæmorrhage into the substance of the tongue and the patient has never had any angio-neurotic attacks. What was the cause? With the help of penicillin, the patient came to operation a week later, and there has been no swelling of tongue or elsewhere since.

Operation

A tracheotomy is performed. The larynx is opened in the usual way, the trachea packed off, and the anaesthetic continued per tracheotomy tube. It is now possible to see the extent of the cyst and its relations (Fig. 2).

An incision is made in the aryepiglottic fold about 5 mm. above the edge of the ventricular band. The fibres of the exposed aryepiglotticus muscle are split, and the medial wall of the cyst located. The outer wall is in relation

to the inner side of the thyroid cartilage and thyrohyoid membrane, from which the growing cyst has stripped up the epithelium of the pyriform fossa (Fig. 3).

By gradual dissection the cyst wall can be removed (completely or piecemeal) through the incision. It now remains to remove any redundant pharyngeal epithelium, and to anchor the remainder to the outside of the

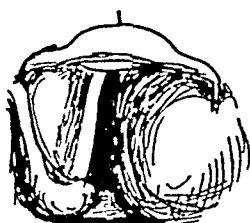


FIG. I.

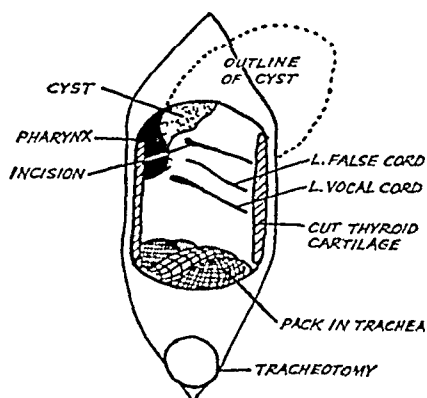


FIG. II. (LARYNX OPENED)

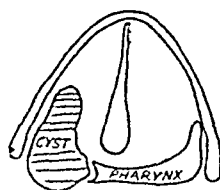


FIG. III

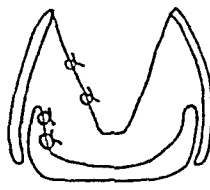


FIG. IV.

larynx with one or two catgut stitches in order to restore the contours of the pyriform fossa (Fig. 4).

The incision is then sewn up, and the rest of the larynx and skin joined in the usual manner. The tracheotomy tube is left in two or more days.

The post-operative period is uneventful, and the first three patients have normal voices. There is no clinical abnormality except for a scar in the neck, which might have been less obvious had it been transverse. The fourth case

Clinical Record

has only been done recently. A transverse incision proved no hindrance, and a $\frac{1}{8}$ in. circular saw used on a dental handle shortened the operating time.

The cyst wall is made up of ciliated columnar epithelium. There is round celled infiltration and fibrosis.

Comment

The morbid anatomy, as found at operation, of four similar cases of laryngeal cyst, is described.

In their growth these cysts extended upwards and laterally, in the line of least resistance, where they stripped up the pharyngeal epithelium, and hence everted the upper part of the pyriform fossa.

It is possible that these tumours are in fact laryngocœles which have become sealed off and filled with exudate.

Operation by the thyrotomy route has proved successful.

SOCIETIES' PROCEEDINGS

ROYAL SOCIETY OF MEDICINE—SECTION OF LARYNGOLOGY

November 7th, 1947

President : A. J. WRIGHT

Snoring

By IAN G. ROBIN

THIS short paper is a plea for the more serious consideration of a complaint which is often a distressing physical and mental handicap. It may ruin a happy marriage, and in some parts of the U.S.A. it is considered justification for divorce. Up to date it has been treated as a comic pastime, and the unfortunate adult sufferers (and even more the agonized relations and associates) have to bear with it in fear of ridicule.

There is almost no world literature on the subject except for the Japanese observers who have devoted some time to it. But we can gain some useful information on the matter from recent work by anatomists and orthodontists who have been studying the mechanism of palatoglossal movements and their relationship to mouth breathing. I am indebted to Dr. J. Whillis, Mr. Gwynne Evans and Mr. A. Nove for most helpful personal conversations.

Definition.—Noisy respiration during sleep may be produced during inspiration and expiration by various structures in the respiratory tract. I propose to limit snoring to sounds made by vibrations in the soft palate and posterior faucial pillars during sleep. This definition excludes sounds made by laryngeal structures including the epiglottis, by the tongue, cheeks, lips or nostrils. Snoring is usually produced during inspiration through the mouth. Sometimes, however, breathing is through the nose (Negus says this occurs in some "gifted individuals"). A short inspiratory snore through the nose with the mouth open may be called a "snort" and some persons are addicted to a series of snorts.

Snoring is involuntary : it stops as soon as consciousness is regained.

Mechanism.—Whillis has shown very clearly by means of a pharyngoscope that the vibrating part in a snore is the thin edge or velum of the posterior faucial pillars. He proved that a reservoir of air is necessary in the nasopharynx : if this space is completely filled the velum cannot vibrate. He also demonstrated that the velum is set in vibration during respiration (usually inspiration) when a "critical point" or position is reached in the relative position of the tongue and soft palate. But not only is it *position* that influences the vibrating parts, it is the *texture* of the velum, and this depends on the tone of the musculature of the glossopharyngeal arch, and the thickness of the tissues (especially the mucosa). The actual pitch of the sound is determined by the so-called "flutter-ratio" of the faucial pillars : Strauss likens the physics

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to a fluttering flag in a wind—any increase in the force of air intensifies the noise but does not change the pitch. This depends on the density, elasticity, and size of the vibrating part.

Position of the soft palate—When sucking the infant's soft palate is in close apposition to the back of the tongue (fluid being squirted intermittently back into the pharynx). A suckling is therefore unlikely to snore during sleep as the relation between tongue and soft palate is unlikely to change. When the chewing habit develops the soft palate is raised away from the tongue. If mouth breathing occurs for any reason the palate is free to vibrate. In adults the position is regulated by the tone of the muscles as well as the amount of airway in the nose. Nove maintains that a short ramus of the mandible makes the palate lie away from the dorsum of the tongue.

Position of the tongue—This plays some part in determining the "critical point". If during mouth breathing the dorsum is arched or falls back, then it will be near to the velum of the fauces. The position of the head may govern that of the tongue. Sleeping on one's back is considered a common cause of snoring, because the tongue falls back more readily. The act of swallowing (the mechanism of which is so admirably described by Negus in 1942, *Proc R Soc Med*, xxxvi, 85) actually inhibits that of snoring, there may be complete cessation or resumption, depending on whether the tongue returns to the snoring or "critical" position, and also whether the reflexes to be described are inhibited.

With regard to the position of the tongue there seems to be no influence from the presence or absence of teeth or dentures in the production of snoring. On the other hand an orthodontic 'monoblock' or 'Andresen' splint can mould the dental alveolar pattern (probably without changing the basal bone one) and so lead to less mouth breathing.

Tone of the glossopharyngeal musculature—This has a governing role for the "critical point", as it decides the positioning and elasticity of the parts. Gwynne Evans and Whillis agree that there is a "central reflex" determining the control of the muscle groups i.e. muscle behaviour is patterned by the CNS. These patterns are inherent developments of inborn conditioned reflexes predestined in foetal life. An inhibition of central control will thus upset the muscular balance. Gwynne Evans associates immobile palatolinguar with immobile orofacial musculature as in so called "adenoid facies".

It can be put forward as a plausible explanation of snoring that during sleep there is a fall in adrenal secretion. This leads to a rise in parasympathetic over sympathetic action, and therefore a diminution of tone in the palatal structures.

In sleep there is said to be a rhythmic variation of depth. At first considerable depth, then lighter sleep and then before waking another increase in depth. If this is true one would expect snoring to occur more readily early in sleep and then just before waking. Actually severe sufferers snore all the time.

In anaesthetized patients it has been said that a real snore does not occur—but this is not true—at any rate sounds just like snoring are heard. Dr Vevers of the Zoological Society has told me that he has heard a chimpanzee snore under an anaesthetic.

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Other factors influencing the position and tone of the glossopharyngeal structures.

—Certain conditions other than that of nasal obstruction lead to slight œdema of the palatal mucosa, or loss of tone in the muscular velum. Slight pharyngitis from working indoors, and from smoking, obesity, plethoric tendencies, and allergic manifestations have all been listed as aggravating causes. One observer has described snoring as one of the diagnostic signs of leprosy of the pharynx; if this were so, one would expect any granulomatous condition in the pharynx to lead to snoring. That a mobile palate is essential for snoring is utilized by speech therapists in the "snorting test" in training cleft-palate patients.

I must mention that in America some prominence is given to the psychological aspect of causation. An article entitled "Does a contented person snore?" shows the trend of thought. It is considered that some snorers stop the habit when on holiday, and others have cycles of snoring periods regulated by psychological and endocrine factors. Personally I think this unlikely, but Gwynne Evans' theory of "central reflexes" makes it not impossible for basal or even higher centres to decide if and when we snore.

Ætiology.—At first thought it appears that the explanation of snoring would be simple enough. Any organic condition causing nasal obstruction would lead to mouth breathing, and a snore would be unavoidable. But this is not so: mouth breathers do not all snore. Causes must be divided into organic and functional or, better, dysfunctional, and although the main predisposing cause may be organic there is usually a dysfunctional cause as well.

A. *Organic causes.*—(1) *Nasal obstruction.* It is often the minor degrees of obstruction which lead to enough mouth breathing to initiate snoring, e.g., slight deflection of the septum, collapsed alae nasi, or moderate mucosal congestion.

Dr. Vevers tells me that although he has never heard a wild wolf snore, many domestic dogs, all descended from the wolf, do so. He imagines this occurs in breeds with malformation in the nose and nasopharynx, caused by such conditions as achondroplasia, as seen in pekinese, etc.

(2) *Pathological changes in the pharynx* may make the soft palate and faucial pillars more liable to be in a suitable physical state for snoring to be initiated.

B. "*Functional derangements*"—or "*Dysfunctions*"—of the "central reflex" governing the tone of the glossopharyngeal musculature.

Age-groups.—There are three main eras of snoring: in the child, the adult and the elderly person. In children the majority are cured by removal of their adenoids and tonsils. The exceptions to cure include the persistent mouth breathers of "functional" origin and those with infective or allergic rhinosinusitis.

The adult who starts snoring usually does so from some organic cause. Women snorers appear to be as numerous as men.

The largest group of sufferers are elderly men and women. Lack of tone seems to be the fundamental cause.

TREATMENT

A. *Irrational methods.*—Chief amongst these is amputation of the uvula, which used to be a popular practice. Removal very rarely gives much relief, but it may modify the degree and pitch of the snore.

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B *Rational methods*—(1) *Remove or prevent nasal obstruction*, and so allow for cessation of mouth breathing. In some instances simple decongestive nasal drops before retiring will allow a peaceful night. In others various nasal operations may have to be performed. Benadryl is useful for some persons.

(2) *Change position of head* to prevent tongue falling back. Many persons snore only when on their backs, and on some occasions the uncomfortable procedure of a cotton reel sewn into the back of the pyjamas is efficacious.

(3) *Alter position of tongue, soft palate and/or jaws*, by breathing, swallowing and phonetic exercises, or by orthodontic "splints". The former aim at training the central nervous system to regain proper neuromuscular control. The latter alter the shape of the mouth and thus try to guard against the tongue and fauces falling into the "critical" position.

In all these three groups it is necessary to regain proper central control of the soft palate, and break the habit of an inverted reflex.

(4) *Keep mouth closed during sleep*. This is done by wearing an "Andresen" splint (which is well tolerated by most children, but less so by an adult) or by the simple expedient of a strip of adhesive plaster across the corner of the mouth. After a short time this is well tolerated by many patients. An adequate nasal airway is of course essential.

C *Altering texture of soft palate and faucial pillars*—Injection of a sclerosing solution into the pillars is advocated by Jerome Strauss, though this enthusiastic surgeon has not been able to claim a high percentage of cures so far.

However, I feel we surgeons may have helped many potential future snorers by our effort at removal of their tonsils and adenoids—leaving them with nothing but a fixed fibrous band instead of nice mobile soft palate and faucial pillars!

CONCLUSIONS

Snoring is a symptom of unbalanced breathing, caused by a combination of several physical conditions some brought about by pathological and other by physiological disorders. Remedies must aim at preventing all these causes and not only one.

December 5th, 1947

FILM SHOWING ORGANIC DISORDERS OF THE LARYNX

G. H. BATEMAN said that some months ago he had shown the Section a film illustrating bronchial neoplasms which Dr Paul H. Holinger, of St Luke's Hospital in Chicago had taken. Dr Holinger had now sent him a film entitled "Organic Disorders of the Larynx", which had been prepared from Dr Holinger's own cases and had been sub-edited and annotated for showing to medical students and speech therapists. He had had the opportunity recently of talking with Dr Holinger about his method of taking films by indirect laryngoscopy. The patient sat upright facing the operator who used the same camera and apparatus as was used for the direct pictures. The laryngoscopic tube was used and a mirror obliquely disposed at the end of this tube. Thus the mouth did not appear in the films as the view is confined to the mirror and its reflections. In direct laryngoscopy the mirror was removed and the laryngoscope tube introduced in the ordinary way, with the patient

Societies' Proceedings

having his back to the surgeon. All the pictures were taken under local anæsthesia.

The result of this change of position of the patient is that the right cord will be on the right of the screen in the direct pictures and on the left in the indirect pictures.

A considerable range of pathological conditions of the larynx is shown and the treatment mentioned though no details of treatment are given in the film. The colour is very accurate and the film is an admirable method of demonstrating the pathology of the larynx to students.

BELL TELEPHONE FILM OF THE LARYNGEAL MOVEMENTS

V. E. NEGUS showed a film taken by indirect laryngoscopy with an ultra-rapid camera. The pictures were taken at 4,000 frames per second and slowed down to normal rate so as to show the laryngeal movements in slow motion. Mr. Negus said that this film differed from the beautiful film they had just seen in that it showed the normal mechanism instead of diseased states.

Many of those present, like himself, had no doubt made use of the stroboscope, from which a great deal of help could be obtained in observing the laryngeal mechanism. On the evidence of the stroboscope was based a certain amount of the criticism he would make of the film. The stroboscope consisted of a perforated disc so rotated in front of a lamp that the light could be interrupted a certain number of times per second; the speed could be altered at will. If the speed were 200 times per second, for example, it was possible to illuminate the larynx at exactly the same rate as that of the sound produced. If the pitch were at the rate of 200 vibrations per second the vocal cords for $\frac{1}{400}$ th of a second would be moving towards the mid-line and for $\frac{1}{400}$ th of a second away from the mid-line. If only one phase were illuminated the cords appeared to be stationary. By varying the speed the light of the stroboscope could be made to interrupt at 201 times per second, while the patient was still phonating at 200 double vibrations. Every time, therefore, the cords would be illuminated a little sooner or a little later than before, and it was possible to see, for instance, whether the arytenoids came firmly together or whether they remained separated; so that actually an even slower picture could be obtained than with this film.

The normal mechanism of phonation consisted of approximation and separation of the vocal folds. In this the arytenoid cartilages should come together and should remain firmly apposed and should not vibrate. There were theoretically two ways of raising the pitch: one was by stretching and tightening the cords; and the other by increased contraction of the arytenoid muscles, whereby the elasticity of the glottic margins increased and the vocal cords therefore recoiled more rapidly than when the muscles were less powerfully contracted. When this contraction took place the pull of the adductor and tensor muscles was so strong that the fold was shortened. The rise of pitch depended on the increase of elasticity of the thyro-arytenoid muscles, due to their increased contraction, and not on stretching of the cords.

A second point was the position of the arytenoid. How the arytenoid cartilage remained in a certain position would be shown in the film; also the

Royal Society of Medicine

eversion of the vocal folds, which did not merely separate in a lateral direction from each other but had a sort of rolling movement. Also, as the vocal cords shortened, the aryepiglottic folds would be observed coming forward. Looking from above, the epiglottis appeared to tilt forward and to display more of the vocal fold as the pitch rose.

A third part of this film showed how the glottis was blown open. If the thyro arytenoids contracted and held the cords together the glottis would suddenly be blown open on phonation, and then the elasticity of the glottic margins was sufficient to bring the folds together again, the repetition of this process producing a sound of a fixed pitch. In some cases it was only a short part of the glottis that opened. In another part of this film would be seen the mechanism of whispering.

If by some means there was lack of apposition of the arytenoid cartilages, and if the vocal processes were kept slightly apart, there would be a disturbance in the vibration of the cords. If the posterior ends were not kept close together the vocal cords would bang together and impinge unduly at their centres. In the higher pitches it would be noticed that only the margin of the cords separated, without the eversion which was shown in the lower pitches. The last part of the first reel showed vibration at 850 vibrations per second.

One point of interest in the second reel was that one vocal cord was seen to be vibrating more than the other. It was possible for the patient to produce a sound almost entirely by vibration of one vocal cord the other remaining stationary. It might be because of this that there were very few singers with completely pure tones. Another effect shown was the rise of pitch when the patient breathed helium. If helium with oxygen were given to a patient with dyspnoea it could be determined whether it were given efficiently by the manner in which the pitch of the voice rose.

V E. Negus added that in the textbook *Diseases of the Nose and Throat*, by the late Sir St. Clair Thomson, Fig. 33 showed the imperfect view of the larynx obtained by the beginner because the epiglottis overhung part of the vocal cords and made the view incomplete. If one held a laryngeal mirror against the hard palate and got the patient to make the sound "E" it was often possible to see the whole of the vocal cord, including the anterior commissure, without causing the patient to feel sick. The mechanics of the elevation of the larynx were somewhat complicated. As the pitch rose the larynx was usually elevated to a certain extent and brought up towards the hyoid, and in doing so was tilted so that the vocal cords came to be more at right angles to the axis than at low pitches.

Mr. Forster had spoken of a phenomenon of the right arytenoid in phonation being well in front of the left. One might be led into error if one based a supposition of paralysis on the fact that one vocal cord did not move as well as the other. It might be simply a functional process. In all cases of functional disability the Wrisberg cartilage would be upstanding and in the usual position but in all cases of organic paralysis, the posticus being the first to be affected, this cartilage would fall forward, and the aryepiglottic fold would obscure the vocal cord. It was quite easy to distinguish between the two conditions. On the one hand the patient might have a mediastinal mass, or else the whole laryngeal condition might be functional and due to a slight disorder of muscular

Societies' Proceedings

effort ; it was difficult for the contraction of the two sides of the larynx to be equally balanced.

The vocal cords themselves were of such small mass that they could not produce much sound. The sound was not made by vibrations similar to those of a string, but by the interruption of the air current into puffs. Only by the modification and amplification of resonators was speech and voiced sound produced.

ABSTRACTS

EAR

Congenital Cholesteatoma A RICCABONA *Monatsschrift fur Ohrenheilkunde*, 1947, lxxx1, 305

A 70 year old woman was admitted unconscious to hospital with the diagnosis of apoplexy. There was a history of old standing nephritis and a facial palsy. Seven days previous to admission she had an influenzal infection and suddenly became unconscious. Death occurred a few hours later. The drumheads were normal. Post-mortem examination revealed a meningitis and a large cholesteatoma between dura and temporal bone extending from the eminentia arcuata to the tegmen tympani and antrum. A large area of bone was eroded, including the internal auditory meatus, the superior semicircular canal, the roof of the mastoid antrum and attic. The facial nerve was partly destroyed.

The position and great extent of the cholesteatoma, the absence of perforation of the tympanic membrane and the intact mucous membrane of the middle-ear cleft support the view that this was a primary congenital condition. The great bone destruction may be accounted for by the cholesteatoma lying on the cranial aspect of the petrous and interfering with the arterial supply and venous drainage of the affected area. The rest of the temporal bone being supplied by the external carotid would not be involved.

DEREK BROWN KELLY

On Aural Cancer with Special Consideration of the Development and Course of Basal cell Carcinoma in the Region of the Ear E URBANTSCHITSCH (Vienna) *Monatsschrift fur Ohrenheilkunde*, 1947, lxxx1, 526

After discussing the rarity of the condition, the author describes three cases of basal celled aural cancer originating in the external canal.

In two of these, despite X-ray therapy, the growth extended to the middle ear and mastoid, so that radical operation became necessary. The first healed well as regards the operation cavity, and received post operative radiation. Death however, took place after gradual destruction of one side of the neck by the cancerous process. The second case also radiated, had no further extension of the growth, but the operation cavity showed little tendency to heal.

The third patient, who received no X-rays, healed completely, and remained well until five years later, when he died from gastric ulcer.

It appears, therefore, that in basal cell carcinoma of the ear, X ray therapy is only indicated if there is tumour tissue in the operation area or its neighbourhood which cannot be removed.

DEREK BROWN KELLY

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effort ; it was difficult for the contraction of the two sides of the larynx to be equally balanced.

The vocal cords themselves were of such small mass that they could not produce much sound. The sound was not made by vibrations similar to those of a string, but by the interruption of the air current into puffs. Only by the modification and amplification of resonators was speech and voiced sound produced.

Nose

On Cerebro spinal Rhinorrhœa L HORBST (Innsbruck) *Monatsschrift für Ohrenheilkunde*, 1947, LXXI, 505

The ætiology, symptoms and clinical manifestations of cerebrospinal rhinorrhœa are discussed. The chief causes of the condition are —(1) Fracture of the base of the skull (2) Infiltrating and expanding growths of the brain and base of skull (3) Destructive processes in the region of the ethmoid (4) Basal encephalocele (5) Congenital defects in the lamina cribrosa (6) "Spontaneous cases" in which no cause can be found on clinical examination.

A case, apparently belonging to the latter group is recorded. This concerns a man aged 50, who developed a discharge of watery fluid from the left nostril six months after a motor accident. Careful investigation failed to reveal the cause. The patient eventually died after an acute meningitis following a cold. Post mortem examination showed a purulent lepto meningitis with multiple abscesses in the left cerebral hemisphere. The left sphenoidal sinus contained pus, and a perforation of the clivus had taken place at the site of an intra-osseous chordoma.

DEREK BROWN KELLY

BRONCHI

On the Symptoms of Bronchial Stenosis D KASSAY (Budapest) *Monatsschrift für Ohrenheilkunde*, 1947, LXXI, 225

The author classifies bronchial stenosis on a symptomatological basis. He recognizes three main groups: 1 Simple stenosis 2 Variable stenosis 3 Permanent stenosis. The effect of breathing on the mediastinal shadow and diaphragm in both normal and obstructed cases is demonstrated by diagrams.

The causes and effects of valvular stenosis are detailed. In connection with incomplete valvular stenosis, a new observation is made. The lifting up of the lateral and anterior insertions of the diaphragm (caused by breathing) play an important part in the production of paradoxical diaphragm movements.

The special difficulty of establishing a diagnosis of valvular stenosis in the case of infants is explained. The author concludes by describing the types and symptoms of atelectasis. Eight case records are given. Special reference is made to the Holzkecht-Jacobson sign which was found to be true in every case. This states that the movement of the mediastinal shadow on inspiration takes place towards the diseased side without exception.

DEREK BROWN KELLY

LARYNX

Loss of Singing Voice and Severe Speech Disturbance following Bilateral Peripheral Hypoglossus Paralysis G ARNOLD *Monatsschrift für Ohrenheilkunde*, 1947, LXXI, 195

A professional singer developed an osteoma on the inner side of the lower jaw following a wound of the chin. He then underwent seven operations, which were later followed by a bilateral hypoglossus palsy. His speech was severely interfered with, and the singing voice lost. This rare form of speech disturbance was thoroughly investigated phonetically, radiologically, and with the stroboscope. The chief factors in the disorder were the paralyses of the

neck muscles served by the hypoglossal nerve and especially the failure of the sterno-thyroid muscle. Knowledge of this condition is necessary when undertaking operations on the neck if interference with the voice is to be avoided. The outer laryngeal musculature must be carefully preserved in all such operations.

DEREK BROWN KELLY.

NOTE

Oto-Rhino-Laryngology. Section XI of *Excerpta Medica*.

We welcome this admirable publication devoted to abstracts from "every available medical journal in the world"; the *Excerpta* has 15 Sections and number XI is that devoted to Ear, Nose and Throat. This section has an index of the different subjects dealt with enabling readers to find pertinent abstracts in a few moments.

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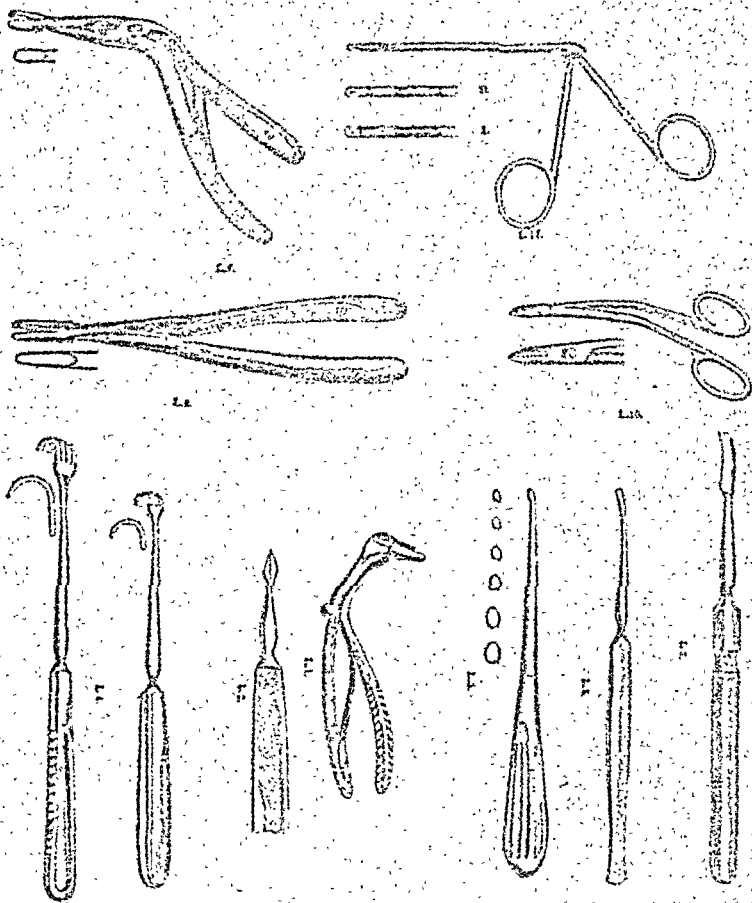
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RHINOPLASTY

AND

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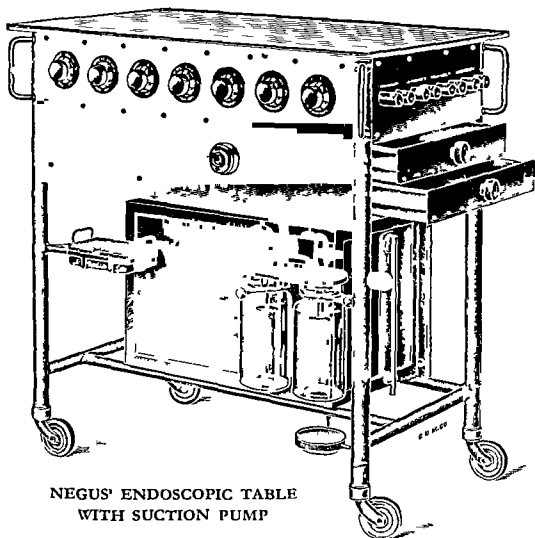
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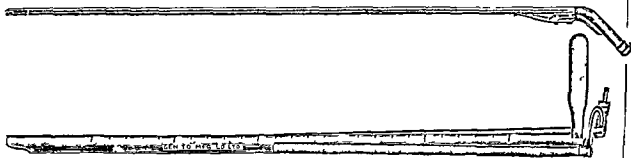
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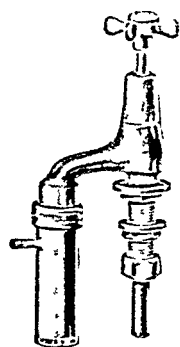
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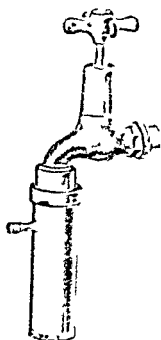
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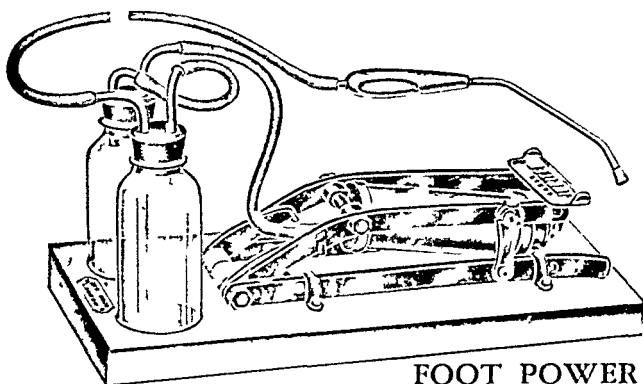


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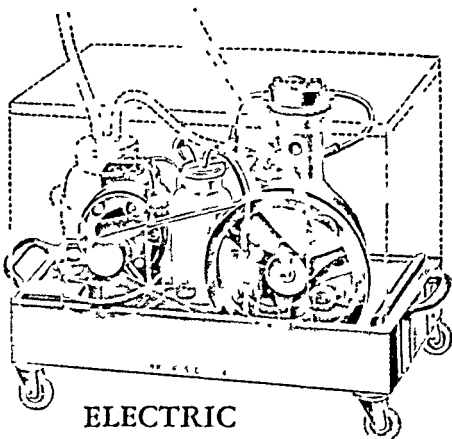
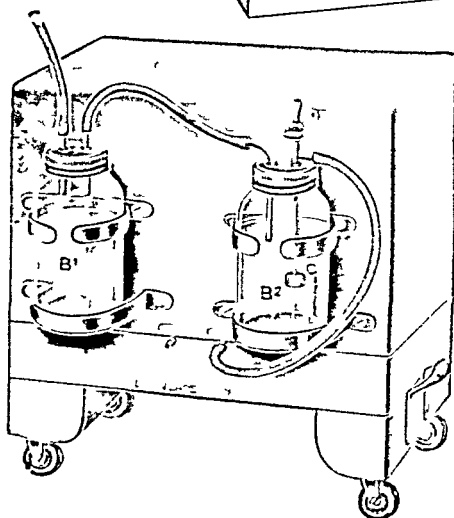


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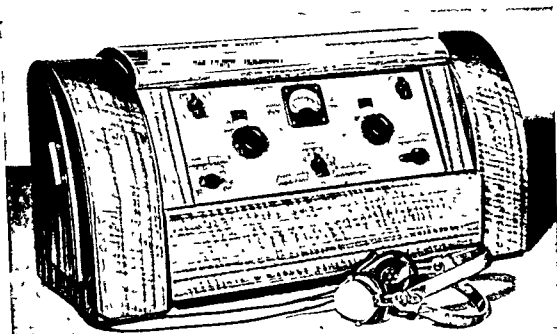
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September 1948

PENICILLIN TREATMENT IN ACUTE SUPPURATIVE OTITIS MEDIA WITH SPECIAL REFERENCE TO LONG-TERM HEARING*

By Dr A YOUNG and Mr I SIMSON HALL (Edinburgh)

THE following records are of a series of cases of acute suppurative otitis media treated in Dr Simson Hall's department and taken to show the therapeutic value of penicillin in this disease, with particular regard to the recovery of function. The series begins in the early part of 1946, when penicillin first began to be available for the treatment of such cases, and extends up to June of this year. The number of cases is 115, so that there is a numerical similarity with the report on 110 cases of acute infection given by Mr Wilson to the Section in June, 1946.

For a considerable time after penicillin came into use alternate cases continued to be treated with sulphonamides in order to establish a control, and comparison was made between the results obtained with the two drugs bearing in mind the then comparatively low cost and the greater convenience of giving sulphonamides. But the use of sulphonamides was later discontinued, partly because of the disadvantage of their masking effect, and from the latter part of 1946 penicillin alone has been used.

For the purposes of investigation certain cases had to be excluded. These are all cases with a previous history of deafness or discharge, all cases which on admission were considered to require immediate mastoid operation, children under the age of five, and all cases with a history of over one month's duration. The average duration proved to be nine

* Read at the Section of Otology Royal Society of Medicine December 1947

A. Young and I. Simson Hall

days from the onset of pain or discharge. The fact that occasional patients had been given some sulphonamides before being referred to the department had to be disregarded. Out-patient treatment was given whenever possible.

Many patients received part of their treatment as in-patients and, when the acuteness of the infection subsided, attended for injections as out-patients.

Method of Administration

Penicillin was given by intramuscular injection. Local treatment consisted of dry mopping. The dose of penicillin for in-patients was 200,000 units daily in three-hourly injections of 25,000 units. Out-patients received 200,000 units daily in twice-daily injections of 100,000 units. The total amount given and the duration of treatment increased as penicillin became more available and less costly. The average dose used works out at 1,300,000 units or just over six days' treatment. The maximum dose was 2,500,000 units. Attempts were made to use single injections daily of oily penicillin to reduce the number of attendances at the department for injections, but patients complained so much of pain and discomfort that this method was quickly abandoned.

The number of cases is 115, and of those 10 were bilateral. The drum was perforated and discharge was present in 56. Of the rest, 44 showed a bulging drum and 15 were mild cases with red but not bulging drums. That so few early or mild cases were seen is not surprising considering the average duration of symptoms before patients attended the department.

In cases with perforation and discharge, an X-ray of the mastoids was taken and a culture of the organisms made at the commencement of treatment. Where the mastoids were pneumatized, 7 out of 8 showed some degree of opacity. In no case was there much evidence of bone destruction in the way of a breaking-down of cell walls, but osteoporosis is shown in some of the X-rays. Hæmolytic streptococci and staphylococci were the commonest organisms and occurred in almost equal numbers, with pneumococci and non-hæmolytic streptococci being found less frequently. Mixed growths or organisms were not infrequent. In no case was a penicillin-resistant organism found.

No definite policy was adopted with regard to paracentesis, and this was only done in 8 cases with a bulging drum. There is no evidence to show that the cases in which this was not done suffered any impairment of function which might have been avoided by carrying out this procedure.

Results of Treatment

A dry healed ear was obtained by penicillin alone in all but six cases. These six cases required the simple mastoid operation, and one in addition

Penicillin Treatment in Otitis Media

required removal of adenoids. The operation was done for persistent discharge in two cases, because of recurrences of infection in two cases, and of the remaining two one developed a Bezold's abscess during treatment and one showed signs of persistent inflammation in the ear and mastoid process.

There were recurrences of infection in ten such cases, and two recurred more than once, with signs of meningitis in one. As noted above, the simple mastoid operation was done in two of these cases before healing finally occurred.

The time taken for the ear to become dry was an average between seven and eight days. The time taken for the drum to return to normal and for the normal hearing of the whispered voice to be recovered was eleven days for the cases in which suppuration was present and nine days for the cases in which the drum did not perforate. Comparable figures for cases treated with sulphonamides are nine days for the ear to become dry, and the time taken for the drum to return to normal and for the normal whispered voice to be recovered was seventeen days in those cases in which suppuration was present and fourteen days for the cases without suppuration.

The Effects on Hearing

There are eight cases in which there remained some defect in hearing, of these only one was at all marked and the other seven could be described as slight and consisted of a loss of less than 5 feet in 20 feet when tested with a whisper in a quiet room. Mr. Wilson in his report recorded a higher proportion of cases with a hearing loss—16 out of 90 cases.

Audiometric records were kept of just over 90 of these cases. These hearing tests were repeated at irregular intervals until it was apparent that no further improvement was to be expected. In some cases satisfactory audiograms were obtained in two to three weeks, but other cases were followed up for two to three months. The cases for which there are no audiometric records are young children and a few adults who did not report after treatment was concluded. The hearing levels for each frequency were averaged out for the normal and the affected ears. They show an average loss of less than five decibels over the ranges from 64 d v to 2,048 d v, rising to five decibels in the 4,096 frequency and ten decibels in the 8,192 frequency. Taking the figures for one frequency—256—as an example, the average loss in this frequency is $2\frac{1}{2}$ decibels which consists of 59 cases with no comparative loss of hearing, 20 cases with a comparative loss of five decibels and 13 cases with a loss of ten or more decibels. The loss of hearing in the high tones is more marked than in the low tones, hearing in the low frequency is usually recovered comparatively early in accordance with the time of recovery of the normal hearing of a whisper. It may be said that the loss of hearing for the

A. Young and I. Simson Hall

upper tones was more marked and that it was more slowly and gradually recovered and was not quite so completely recovered, but this does not apply to all cases, and the order of recovery often varied.

These figures include the eight cases showing deafness to testing with the whispered voice but do not include two cases of young children who had the mastoid operation done.

The audiometric records of the smaller number of sulphonamide cases show little appreciable difference from those treated with penicillin.

We have heard in this Section so many condemnations of the indiscriminate use of sulphonamides that it seemed a matter of urgency to solve the same problems in the case of penicillin.

In the past we would have reported in such circumstances on the recovery rate, on the number of cases lost and the complications encountered, but since the introduction of these life-saving drugs, function has been the object of our treatment, and the audiometer is the scale of our success or failure.

I would like to acknowledge the assistance given by Mr. MacLeod of Nottingham, as well as that given by Dr. Young, in keeping up the detailed and tedious observations.

The standardization of observation and decision presented some difficulty, and in an endeavour to achieve uniformity one surgeon was given charge of all cases of acute otitis media seen in the department, and their disposal and treatment was his sole responsibility.

The introduction of sulphonamides into this series was made because of the fact that succeeding epidemics of acute otitis media present different characteristics of severity and response to treatment, and it seemed probable that as the effects of sulphonamides were comparatively well known they would afford some measure of control as well as an interesting comparison.

We are familiar with the observation made by neuro-surgeons that penicillin fails to penetrate an intracranial abscess until the tension within the abscess has been relieved. It seemed to me almost fundamental to this treatment that this point should be cleared up as early as possible, for if there was no penetration of the drug where there was tension, then paracentesis would be essential if we were not going to risk serious damage to hearing after the otitis had cleared up. We attempted to find an answer to this question by giving a single dose of 250,000 units and twenty minutes later aspirating the contents of the middle ear and submitting the fluid for investigation. The degree of bacteriostasis obtained suggested that penicillin did in fact penetrate into the middle ear, but this experiment is incomplete and, in spite of the results reported to-day, I believe this point would repay further investigation.

Penicillin Treatment in Otitis Media

Results of Final Tests

The percentage of cases which reported for review is 115

Of these cases, 60 per cent show some evidence of impairment of hearing in the affected ear. This defect is not, in general, severe, and except in a few bilateral cases is not a handicap and in many instances is not noticed by the patient.

An interesting point, and one of considerable importance in this matter, is that only a small number, 5 per cent, of those whose hearing returned to normal after the infection had cleared up, showed deterioration on final survey, suggesting that when a final recovery has been reached the prognosis is good. Admittedly 18 to 20 months is too short a period upon which to base a final opinion, but as far as it goes it is satisfactory.

In this connection there is no significant difference between those cases treated with sulphonamide and those treated with penicillin.

As might have been expected of those cases in which there was already discharge when they were first seen, a higher percentage—73—show evidence of final impairment.

Only five cases which had had paracentesis done reported, and two were found to be normal. These figures are too small to be of any value.

X-rays were taken of a large number of patients and, while not strictly within our subject this morning, observations made of these have some points of interest.

Twenty-two patients have been seen within the last month whose previous films showed some evidence of mastoid inflammation and which were available for comparison, and these patients were again X-rayed. Examination of the films together with the audiometric readings seems to show that a degree of mastoid involvement is not of any special significance in the prognosis as regards hearing. Eleven of the twenty-two cases referred to now show normal hearing, and eleven show some impairment.

In conclusion, I think that, on balance, the figures which Dr. Young has given, taken with the end results of hearing tests, show that the advantage lies with penicillin. This treatment, however, must be given with a regularity and care which presupposes the availability of a hospital bed for every case of otitis media. Although this fact is now becoming recognized, the shortage of hospital beds renders the ideal treatment impossible except in a small proportion of cases, and it is a treatment extremely difficult, if not impossible, for the busy practitioner to carry out. For that reason it is something of a relief to find here that the sulphonamides appear to hold their own as far as the final recovery of hearing function is concerned.

What, then, would be a rational treatment for the practitioner to adopt? I suggest that in general we should advise him to rely chiefly upon the sulphonamides on the ground that the proper administration of

A. Young and I. Simson Hall

sulphonamides is to be preferred to the inefficient or irregular use of penicillin.

Such use of penicillin is believed to be responsible for the rapid increase of penicillin-resistant strains of various organisms, and a recent paper by Dr. Mary Barber on the subject contains the disturbing implication that the usefulness of penicillin is steadily diminishing.

Finally, I would stress that penicillin and the sulphonamides are an *adjunct* to surgery and *not* an alternative, and also that my remarks apply only to early acute otitis media.

CAVERNOUS HÆMANGIOMA OF THE FRONTAL BONE

By GEORGE KELEMEN, and EDGAR MILLER HOLMES, (Boston)*

TOYNBEE in 1842 gave the first description of vascular tumours of the parietal bones and ever since similar growths have been observed and followed with attention. Even so, the number of observations remains restricted. Anspach found 21 cases of hæmangioma of the skull recorded, Abbott's exact tabulation reveals a few more. Disregarding tumours of other bones of the calvarium and considering merely growths of the frontal, the data of the literature are extremely meagre. Zajaczkowsky removed a cavernous hæmangioma of the frontal bone (side not given) with a ramification to the sinus. Among several hæmangiomata, in the case of Erós the largest was found involving the frontal bone, developing inside the cranial cavity with a bulging vitrea. Echols and Kleinsasser removed an angioma of the right side of the frontal including the superciliary arch and orbital plate, the sinus was widely opened. Besides the one reported in the following, only the case of Mazzini and Brachetto-Brian and the first observation of Abbott has been restricted to the frontal bone itself. In two or three others, the tumour reached the sinus, here an orientation is difficult as the question remains open if the tumour developed in the sinus wall or merely reached the latter by its later expansion. Dikansky found that during the entire "microscopical era" not more than nine angiomas of the skull were undergoing adequate surgical measures and a competent histological analysis.

Kaplan and Kauser, stating that hæmangioma of the skull is exceedingly rare, found up to 1939 no report of a correct diagnosis prior to successful removal. Only in recent years was it possible to make a pre-operative diagnosis mainly with help of the roentgen picture. The latter reveals the characteristic "sunray" or "sunburst" pattern with trabeculations which radiate from a common centre and mostly from the plane of the bone (Bucy and Capp). On the other hand, as osteogenic sarcoma may present the same picture frequently only histologic examination demonstrated the true nature of the growth. Characteristic are perpendicular striations caused by delicate radiating spicules, the striations pointing against the periosteum, in the flat bones of the skull, while in cylindrical bones the tumour appears as loculated, showing a honey-comb or soap-bubble effect.

* From the Department of Otolaryngology of the Massachusetts Eye and Ear Infirmary

George Kelemen and Edgar Miller Holmes

Many older reports became discredited because overgrowth of vessels is a prominent feature of many cancers, such as carcinomatous metastases, vascular forms of osteogenic sarcoma, Ewing's sarcoma, multiple myeloma (Geschickter and Copeland).

Observation

A white man, 35 years of age, was referred by Dr. S. H. Keshen, Halifax, N.S. Ten years ago he suffered an injury. While playing hockey, he was cut by a skate on his right forehead. Rapid healing followed, leaving an inconspicuous scar. Four or five years after the injury a swelling appeared over the scar, without headaches or other inconveniences. One and a half years ago the bony growth was removed by operation (without removal of the inner table?). Healing was prompt again but the swelling soon returned and was now growing much quicker than before.

On admission, the patient was found to be in excellent health, without headaches or other complaints. A thin, smooth scar ran in a wrinkle of the right forehead, hardly visible. The skin was elevated in an area of 2.0 to 1.8 cm. by a uniformly hard mass. It arose from the plane of the frontal bone with a smooth slant medially and ended with an abrupt escarpment laterally. The roentgen picture (Dr. A. S. Macmillan) showed a rarefaction of bone about 3.5-4.0 cm. in diameter of the right frontal bone 0.5 cm. above the brow and 1 cm. from the lateral end of the right frontal sinus. A lateral view showed that there was loss of the outer cortex of the frontal and apparently an overgrowth of the medulla of the bone in this area. The inner cortex of the bone seems intact. Diagnosis: Spongy osteoma.

Under general anaesthesia, an incision through the old scar was made and the mass exposed. The periosteum was seemingly absent over the area but could be elevated over the bone about its base. A single trephine opening was then made through both tables at the outer lower angle of the mass. Then with a rongeur a gutter was cut around it so that the tumour and the inner plate could be removed. It was adherent to the dura so that in two places small holes were seen and cerebrospinal fluid leaked out. One place was at 5 o'clock, another at 10 o'clock near the periphery. A tantalum plate was then cut, perforated, shaped and placed over the defect and held in place by the periosteum. Interrupted dermalon sutures approximated the skin edges and a pressure bandage was applied. Penicillin was given for nine days and the healing was uneventful.

The roentgen picture of the specimen showed a honeycomb structure with a mass of radiating spicules. After decalcification, paraffin sections were cut in a sagittal plane to include the outer and inner tabula in the same section. Microscopy of unstained sections in full and polarized



FIG 1 — A LATERO LATRAL AND B ANTERO POSTERIOR ROENTGENOGRAM
A shows the fine trabeculations in front with the posterior tabula preserved B shows the area of rarefaction
corresponding to the tumour

George Kelemen and Edgar Miller Holmes

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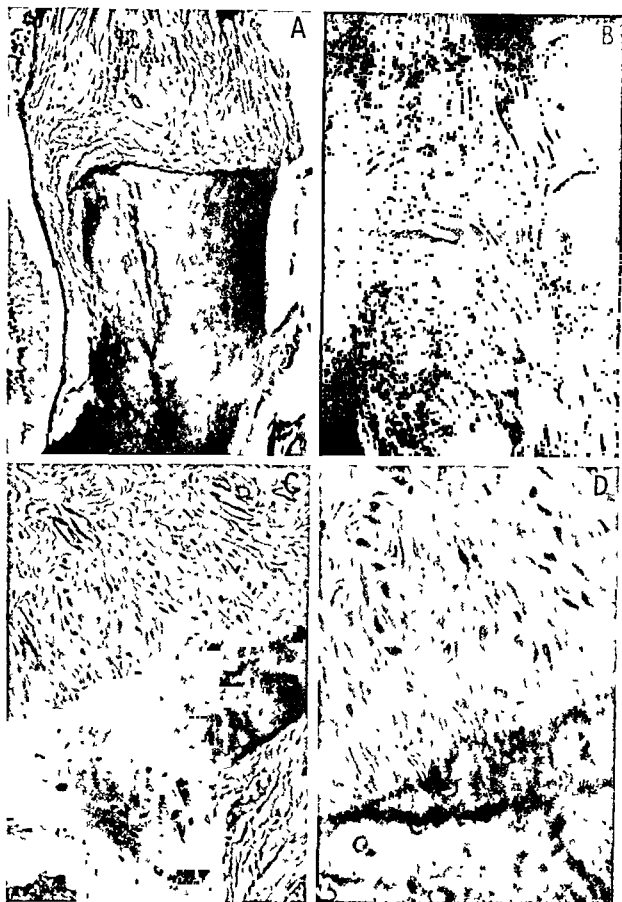


FIG 3—RECONSTRUCTION

A—External tabula interrupted by the tumour with a sharp edge. Periosteum temporarily fills the gap. Well stained bone cells identify the process as a recent one. Hæmatoxylin eosin $\times 300$

B—Attempt to close the gap in the external tabula by small particle of newly built bone. Note regularity of the lamellary pattern. Polarized light $\times 85$

C—New bone built at the inside lower right by osteoblasts, at the outside top by osteogenetic fibres typical for intramembranous ossification. Hæmatoxylin eosin $\times 125$

D—Part of 3 C, $\times 300$. Sharpey's fibres inside and outside the bone. Osteoblasts and bone cells equally well stained active

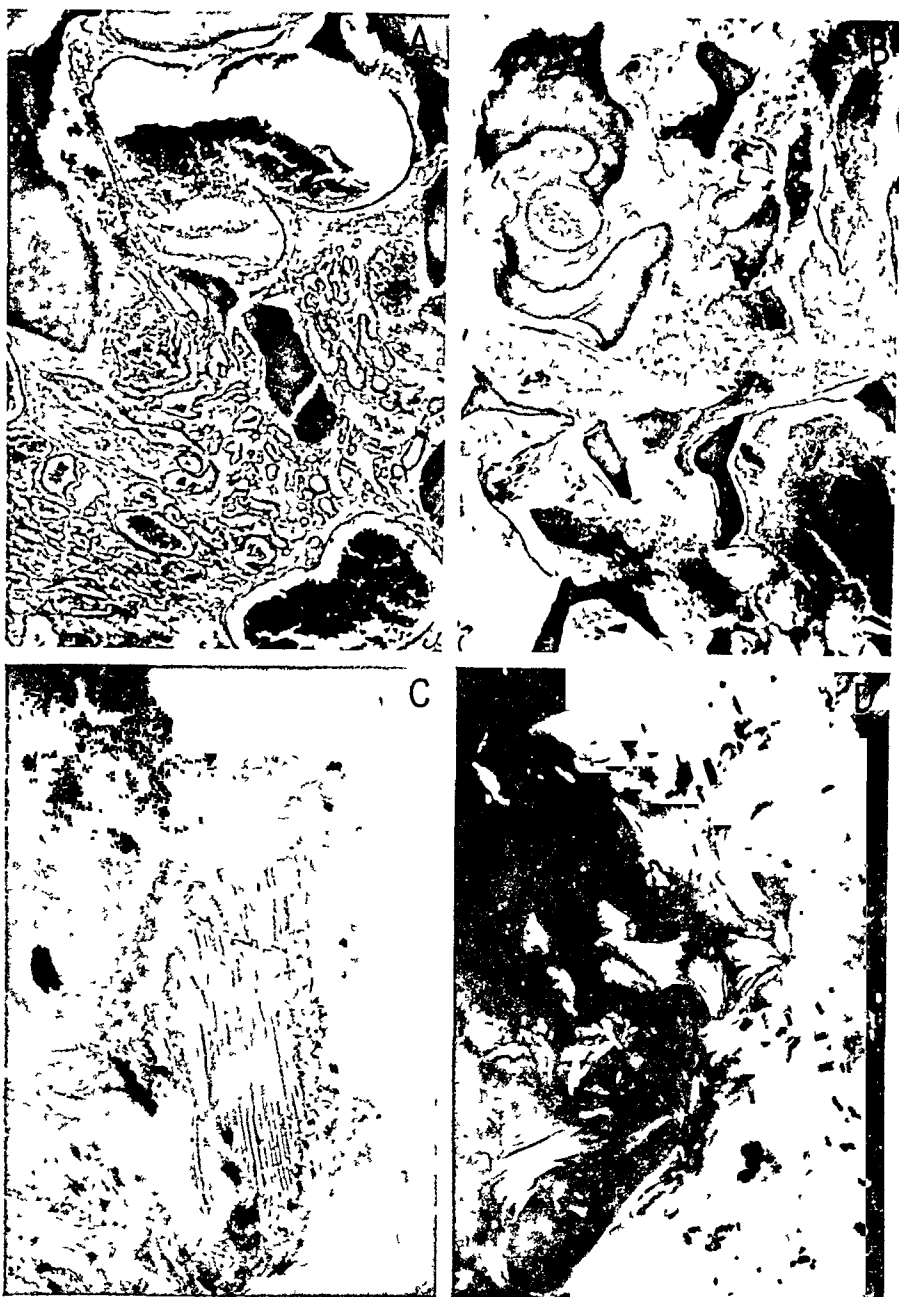


FIG 2—DESTRUCTION

- A—Spongeous, capillary part of the tumour. Larger sinuses originate by confluence. Sinuses filled with blood. Hæmatoxylin-eosin, $\times 125$
- B—The sinuses fill out the marrow spaces completely after destruction of the connective tissue padding. Sinuses filled with blood. Endothelium lines the sequestra of the bone directly. Van Gieson, $\times 65$
- C—Destruction of a small sequestrum by the attack of progressing blood spaces. Fibres of bone falling apart and resorbed one by one. Unstained. Polarized light, in intermediary position between full light and extinction. $\times 65$
- D—Sequestrum surrounded by smallest particles—bone-dust, the latter washed into the blood spaces. Unstained. Polarized light. $\times 65$

Cavernous Hæmangioma of the Frontal Bone

light was used besides staining with hæmatoxylin-eosin, Van Gieson and Gomori-impregnation.*

The tumour was identified by Dr. Benjamin Castleman, pathologist, as a cavernous hæmangioma. Our histological findings are as follows :

The outstanding feature is given by the vessels. Adjacent to the normal bone and to the surface dense conglomerates of capillaries are seen, with thin endothelial walls and rich padding of fibrous tissue between the convolutions and the bony wall. This interstitium diminishes against the centre of the growth and the lumina of the vessels become gradually larger by confluence. Finally very large venous spaces are formed, filled with blood and occasional clumps of fibrin, the padding is gone entirely so that the thin endothelial wall of the vessel lines the bone directly. As long as there is any connective tissue a certain amount of lymphocyte-like myelocytes is seen in its meshes. In the very centre nothing remains besides coalescing blood sinuses and receding bone.

Very near to the sharply-cut edge of the normal outer tabula some disintegrating remnants of the latter are seen. Against the centre the trabeculae become rapidly smaller, until in the region of the largest blood sinuses only very small sequestra are left. Reduced later to bone dust, clumps of the latter are seen within the blood spaces in reabsorption. The destruction is rapid as shown by well-stained nucleated and branching bone cells even within the smallest sequestra ; their canaliculi are broken up to open directly into the sinusoids.

While the bone substance is vanishing by rarefaction in the centre, near the surface vivid osteogenesis is observed. To a small extent this is due to osteoblast rows but only in the corner near the normal bone and only at the inside of the interrupted trabeculae. Osteoclastic activity is rare within the tumour, while in the normal part it is more conspicuous than apposition. The main bony growth is accomplished here by intramembraneous ossification at the ends of the trabeculae which are pointed against the surface. Fibres furnished by the periosteum bury themselves by producing osteoid substance. The perforating fibres can be easily followed far inside of the newly-formed bone. The outgrowing delicate spicules point against the periosteum and show two types. Some are of a " quiescent " nature, with a blunt cap formed by a few lamellae parallel to the surface. Others, far more numerous, protrude fingerlike against the surface, terminated by small bludgeons by embedding directly the fibres of the periosteum. The findings correspond to a cavernous angioma with small areas of a capillary type.

* The histologic work was carried out by Miss Dorothy Lenden. The photomicrographs were prepared by Richard W. St. Clair, head of the Photographic Laboratory of the Massachusetts General Hospital.

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Comment

Trauma was present in the history here as in almost all the other cases. Sometimes small repeated injuries are reported. The development may take a long time : in the case of Echols and Kleinsasser twelve years, in our own about ten. Operation as a form of trauma plays its rôle when after insufficient removal the expansion is accelerated. In two cases, Zajackowsky's and our own, a previous operation removed only the external tabula and the diseased marrow, but left the inner tabula intact. In the present case this procedure may have seemed justified at the first operation with the inner tabula intact according to the roentgen finding even before the second intervention. But it is evident that a similar procedure must be insufficient even to remove the entire changed spongiosa ; the bone has to be dissected in its full thickness. In the case of Kaplan and Kauser the inner and outer tables were thinned but intact. As they assume that the tumour arose from a centre in the diploe, their findings may represent an earlier stage than our case, with the destruction of the tabulae not yet completed. Inner and outer cortices presented cribriform perforations in the case of Erös. The thin brittle vitreous gives way easier than the thick and tough outer tabula ; in Abbott's case the outer table was completely replaced by the mass.

Sometimes the operation had to be discontinued because of severe bleeding, as in the case of Anspach, where the inner table was preserved. In this connection the conception of Ribbert as quoted by Dikansky is of interest : angiomas are not connected with the vessels of the surroundings by abundant and uninterrupted pathways but through a single afferent and a single efferent conduct ; though one may encounter abundant bleeding at the removal it will stop abruptly when the growth is totally eliminated. In our case the ablation was accomplished by working through healthy bone and almost no bleeding was experienced. According to Mazzini and Brachetto-Brian, the rare " non-communicating " angiomas are characterized by a telangiectatic condition of the diploe, with no circulatory connection between the new growth and the soft parts of the surroundings.

Removal of the entire thickness of the bone appears necessary if we consider the *histogenesis* of the tumour. The part where abnormal activity was started by the trauma is the vessel system of the spongiosa. In this centre destruction reaches its maximum by confluence of venous spaces to sinuses, with increasing pressure exerted against the bone wall. This pressure destroys first the connective tissue padding between vessel and bone. With the connective tissue gone the matrix for osteoblastic activity is lost. The bone is thus deprived of its defence mechanism of building new lamellae. Soon the bone substance itself is attacked by the expanding sinuses, the lacunae are broken up and the process goes on until the smallest spicules are ground up to bone dust, which is then

Cavernous Hæmangioma of the Frontal Bone

washed out into the blood spaces to be reabsorbed. The most active elements seem to be the endothelial cells. Probably one has to look at these cells for the first response to the trauma.

The destruction of the bone does not occur always according to the same mechanism. In case two of Dikansky the resorption was effectuated mainly by osteoclasts. Erós saw scarce groups of osteoblasts and osteoclasts. Mazzini and Brachetto-Brian saw trabeculae in the vicinity of the vascular formations, undergoing a "process of simple atrophy", while the greater part of the trabeculae showed considerable hypertrophy.

Regeneration of bone being impossible after destruction of the matrix of osteoblasts in the marrow spaces, the only area left open for reactive osteogenesis is restricted to the surface. Here the periosteum, itself under attack from the part of the expanding blood spaces, offers a supply of fibres which by producing an osteoid interstitium gives a basis for intramembranous ossification. The coarse uncalcified fibres of embryonic bone are encountered in later life only in certain locations as at sutures and areas of insertion of tendons. They seem to be "left over" to meet situations where extreme stress is encountered. Pressure of the growing tumour from inward may evoke this tendency when after destruction of the smooth protecting cortical the spicules revert at their external end to this type of osteogenesis. According to Schulz abundance of Sharpey's and elastic fibres which form later bone can be attributed to some mechanical irritation. In this case the pressure of the tumour acts as a stimulant. The microscopic picture of the spicules makes it clear that this tendency to grow out fingerlike by engulfing the fibres is reproduced in the roentgenologic picture of delicate parallel trabeculations. According to Anspach no other benign tumour has so uniformly produced these parallel densities. In the roentgen picture of our case only the marginal parietes showed this regularity with a beehive structure in the centre. This was in full harmony with the histological finding of entirely disorganized bone in the centre and the fingerlike protrusions restricted to the periphery.

The operation found no thick periosteum over the tumour. The histologic picture of this area made it clear that the periosteum was reduced almost totally to the spaces between the protruding spicules. These remnants of the periosteum themselves were undergoing destruction by the enlarging venous spaces.

Jaffé mentions the possibility of spontaneous healing in similar cases. The above-mentioned "quiescent" spicules may give the basis for this reversion. Their caps would form a new cortical by confluence and under this protection the elements of the spongiosa may regain their equilibrium. Anspach mentions that the cortex of the involved bone may not be broken into bits but is replaced by the hæmangioma in a slow, most orderly fashion.

Reversion to the embryonic type of osteogenesis is easier to understand

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when one considers that the area of the new growth is always the tuber frontale, the site of the primary ossification centre of the frontal. A similar mechanism was observed by Furstenberg, in osteomyelitis of the skull: embryonic bone formation going hand in hand with osseous destruction.

Toynbee classified the two vascular tumours which offered the basis of the first observations—tumours “ of a very intricate character ”—under the class of diseases dependent upon an arrest of development. Even simple macroscopical observation revealed to him certain analogies between these diseased portions and the centres of ossification as they present themselves at an early period of embryonic life.

Summary

A cavernous angioma of the frontal bone was removed by operation followed by plastic repair. Of traumatic origin, this extremely rare tumour offered histologically in its centre destruction of the bone by the vessels of the spongiosa which formed first dense conglomerates and later by confluence large sinuses. In the periosteal region reactive osteogenesis produced new bone by reverting to the mechanism of intramembranous ossification. The first impulse for exuberant growth may have been imparted to the endothelial cells of the vascular walls while material for repair was furnished by the remnants of the periosteum.

Reaction to the traumatic impulse resulted in tumoral growth at the site of the primary centre of ossification. Attempts to reconstruction by reversion to the pre-natal mechanism of intramembranous ossification produced the characteristic roentgen picture of delicate parallel trabeculae.

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RADIOLOGY OF THE TEMPORAL BONE

SOME ANATOMICAL ASPECTS

By J. F. O. MITCHELL (Edinburgh) and ROY ASTLEY (Birmingham)

(1) INTRODUCTION

Very often finer points of diagnosis and consequent surgery depend upon accurate interpretation of X-ray films and a sound knowledge of what the different views can show. Nowhere is this more important than in disease of the temporal bone.

The first essential is a good background of radiological anatomy, and it was towards this end that the following investigation was begun, so that we might have a set of standard views of the mastoid with the principal features outlined. These, by comparison with films of the pathological, we have found a great aid to interpretation; what was originally intended as a personal educational process may be of interest and value to others.

The series was based on only one disarticulated specimen and thus does not indicate the range of variation of the normal. Allowances must therefore be made for differences in development and pneumatization.

(2) RADIOGRAPHIC DETAILS

Moulds of dental plastic (which showed faintly with the non-screen technique employed) were made to hold the specimen in position for each of the following views:

Lateral oblique. A true lateral view with a 15-degree tube tilt directing the rays towards the feet.

Stenver's view. An occipito-frontal with the head rotated 45 degrees and a 12-degree tube tilt away from the feet.

Towne's view. A fronto-occipital with a 30-degree tube tilt towards the feet.

Submento-vertical. The standard view.

(3) MARKERS EMPLOYED

Markers as shown in Fig. 1 were employed in various combinations to outline the following structures:

External auditory meatus—a straight piece of wire with a ring at each end. The medial ring (free end posterior) marks the circumference at the drumhead, the lateral and larger (free end anterior)

Radiology of the Temporal Bone

the circumference at the outer limit of the bony canal. The intermediate straight piece runs the length of the roof (Fig 1a).

Internal auditory meatus—a straight piece of wire with a ring at the medial end which defines the circumference there. The straight piece extends laterally along the anterior wall as far as the proximal end of the canal for the facial nerve (Fig 1b).

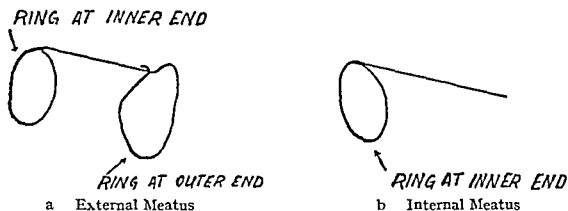


FIG 1 WIRE MARKERS

Middle-ear tract—a straight piece of wire with a hook at each end. The straight piece runs through the bony Eustachian tube, middle-ear cavity and aditus into the mastoid antrum. One end is hooked into the canal for tensor tympani, the other abuts on the posterior wall of the antrum.

Facial nerve—a length of fine wire running from the stylomastoid foramen along the facial canal as far as the genu.

Lateral (horizontal) semicircular canal—surgical removal of its lateral wall at the aditus, and a curved wire in the lumen. The posterior limb extends into the vestibule, the anterior into the ampulla, but the wire imperfectly defines the smoothness of the curve.

Superior semicircular canal—surgical removal of the arcuate eminence, and a curved wire in the lumen. Neither end quite reaches the vestibule, the anterior end again imperfectly defining the smoothness of the curve.

Mastoid antrum—surgical removal of the tegmen antri, and packing of the cavity of the antrum and aditus with thin strips of lead foil.

Sigmoid sinus—a piece of lead foil moulded to fit its bony groove.

(4) THE LATERAL OBLIQUE VIEW (Figs 2-5)

There is marked deviation of the middle-ear tract from the horizontal, and the high positions of the Eustachian opening and the aditus relative to the middle ear are well shown. Fig 2 shows the wire very high in the antrum, but here it is riding up against the roof, while in Figs 4 and 5 it is packed down on to the floor of the aditus.

J. F. O. Mitchell and Roy Astley

The facial canal conforms to its classical description, crossing the middle ear at the level of the upper margin of the drum and turning downwards just behind the posterior wall of the external meatus.

The internal auditory meatus (Fig. 3) approximately coincides with the lower part of the external meatus, while the petrous tip lies well below.

(5) STENVER'S VIEW (Figs. 6-9)

In practice we use this as a routine in place of other variations of the P.A. oblique. With the appropriate exposure technique, it shows clearly in the same picture both the mastoid tip and the petrous bone with details of the middle and inner ear.

The external meatus is foreshortened, and the ring marking the drum-head is seen in relation to the facial nerve, aditus, and antrum (Figs. 6 and 9). The antrum appears much higher than might be imagined. The important proximity of the lateral semicircular canal to the aditus is well shown. In Fig. 8 the bony groove for the sigmoid sinus is also indicated.

The internal meatus, cochlea, superior and lateral semicircular canals are usually well seen in films of the living subject. Each of the canals is seen in its own plane. The marker in Fig. 7 shows that the medial extremity of the internal meatus is not on the "skyline". Therefore pathological enlargement may not be seen as early as one would expect in this view.

(6) TOWNE'S VIEW (Figs. 10-12)

This gives a good general plan of the whole ear, comparing both sides in the same picture.

The medial end of the external meatus indicates the position of the middle ear with the promontory of the cochlea on its medial wall, the Eustachian tube anteriorly and the aditus ad antrum posteriorly.

The antrum is much foreshortened but the "neck" formed by the aditus is shown better than in the other views, thus permitting earlier detection of pathological enlargement. The proximity of the lateral semicircular canal is again apparent. The superior semicircular canal is obvious without a marker and the medial end of the internal auditory meatus more clearly seen than in the Stenver's view.

(7) THE SUBMENTO-VERTICAL VIEW (Figs. 13-15)

This view again compares both sides in the same picture.

The external auditory meatus is easily seen without a marker; but in radiographs of the complete skull its medial end (with the aditus superimposed—Fig. 15) and the adjacent middle ear are apt to be obscured by the ascending ramus of the mandible.



Fig 2
Lateral Oblique



FIG 3
Lateral Oblique



Fig. 4.
Lateral Oblique



FIG. 5.
Lateral Oblique



Fig 6
Stenver's



Fig 7
Stenver's



Fig. 8
Stenver s



FIG 9.
Stenver's



11 10
Towns



FIG. 11
Towne's



Fig 12
Towne's



Fig 13
Submento-Vertical



Fig 14
Submento Vertical

Radiology of the Temporal Bone

The coils of the cochlea are prominent.

In all four views the external and internal auditory meatus lie more or less in one straight line. The middle-ear tract crosses this at an angle approaching 90 degrees, except in this view where, foreshortened, the angle appears more acute.

(8) SUMMARY

(a) A disarticulated temporal bone was investigated radiologically, using markers to indicate the principal anatomical features.

(b) Four views showed the relations of these features in all planes, providing a useful guide in radiodiagnosis.

(c) Insertion of the markers required removal of bone the approximate equivalent of common pathology. Despite the great detail of the radiographs compared with those of the living, it was noteworthy that the defects could not be seen.

THE RADICAL MASTOID OPERATION :

A PRE- AND POST-OPERATIVE AUDIOMETRIC STATISTICAL SURVEY OF HEARING LOSS IN CHRONIC OTORRHŒA

By N. ASHERSON (London)

AUDIOMETRY has now enabled the otologist in cases of chronic otorrhœa to venture an opinion by otoscopy alone of the hearing loss (in decibels) within an insignificant limit of error, and without any interrogation or testing of the patient, or knowledge of the past history.

This generalization has been formulated.

1. For the radical mastoid cavity :
 - (a) whether dry and healed
 - (b) or whether it is still discharging.
2. For chronic suppurative otorrhœa with granulations and/or cholesteatoma.
3. For chronic otorrhœa with the large and the small *permanent* central perforation of the tympanic membrane (tubo-tympanic infection) whether healed or still discharging.
4. For active attic disease.

This is a startling new addition to the aurist's clinical armamentarium. A new chapter has been opened in which *visual* examination will ascertain *auditory* loss in terms of decibels.

The proof of this generalization will be demonstrated in the statistical survey which follows.

As ear consultant to a medical board during the war, about 535 pathological ear cases were examined clinically and the hearing tested. This includes 28 patients (56 ears) with otitis externa. Excluding these, there were 479 cases in which there was (1) a past history of chronic otorrhœa arising from the middle ear, or (2) the ear was still discharging.

I am indebted to Dr. A. W. Gregorson, Chairman and Dr. A. E. Tughan, Vice Chairman of the Medical Board, for referring these cases to me.

Records were made of the hearing using the tests (1) with the acumeter, (2) the whispered voice, (3) the conversational voice and (4) the audiograph for air conduction. All the cases (which formed at least 0.25 per cent. of all the board cases) were males between the ages of 17½ and 40. The real proportion of ear cases was probably higher, as cases of the cortical mastoid operations (with their good and permanent results) were apt to be passed A.I., the past ear condition being ignored deliberately in grading.

The Radical Mastoid Operation

The cases are tabulated under the headings given below, and the statistics indicate the high incidence of chronic otorrhœa in the population, its severe toll on the hearing, and the poor results which persist despite the radical mastoid operation.

These figures confirm the view that the radical mastoid operation is an operation performed too late—after the hearing loss has already become severe.

To conserve the hearing, and to avoid the necessity for the radical mastoid operation, every case of *acute* otitis media should be under operation and active treatment (by the cortical mastoid operation if necessary) until the ear is dry, the tympanic membrane intact and the hearing restored to normal. All these conditions can be secured with the prompt treatment available to-day in contemporary institutions. The day may yet dawn when chemotherapy, with the use of the antibiotics, will still further diminish the incidence of otorrhœa with its severe toll of hearing.

TABLE I

THESE RESULTS BASED ON AN ANALYSIS OF THE HEARING IN 478 EARS WITH CHRONIC OTORRHŒA

Total ears tested, a consecutive series

	Number of patients	%	Number of affected ears
Radical mastoid cavity	36	=12	37
Radical mastoid cavity (<i>contrast series</i>)	16		18
Cortical mastoid operation	17	4	21
Aural polyp	37	9	38
Chronic otorrhœa with granulations and/or cholestea- toma	120	30	153
Attic disease	30	7	30
Sub-acute otorrhœa	12	3	14
Ears dry after otorrhœa, with a residual permanent perforation of the tympanic membrane	97	24	102
Dry ears, with the tympanic membrane healed	46	11	66
	411	100	479

There were in addition other causes of deafness Otosclerosis, 11 cases). Acoustic Trauma There were also Otitis externa, 28 cases feigned deafness (2 cases)

The Hearing Loss in Cases of Pre- and Post-operative Chronic Otorrhœa (After the Radical Mastoid Operation)

The cases are statistically tabulated as follows :

- A Cases in which the radical mastoid operation has been performed for chronic otorrhœa, the cavity having healed up and remained dry.
- B Ditto, but with the cavity still discharging.
- C Cases in which the cortical mastoid operation has been performed in the past for (presumably) pre-operative chronic otorrhœa and the hearing loss. The ears are dry.

N. Asherson

- D Cases of chronic-suppurative otorrhœa, associated with
 - 1. Aural polypus.
 - 2. Granulations and cholesteatoma.
 - E Cases of active and healed otorrhœa, tubo-tympanic infection, associated with a *large* central perforation of the tympanic membrane (bilateral or unilateral), (*a*) ears dry, (*b*) ears still discharging.
 - F Cases of active or healed otorrhœa, with *small* central perforations of the tympanic membrane.
 - G Cases healed after chronic otorrhœa, tympanic membrane intact.
- OTHER CAUSES OF DEAFNESS: Otosclerosis: Feigned Deafness (2 cases: Acoustic Trauma.

Statistical Summary

The audiometric statistics of chronic otorrhœa reveal some interesting data, much of it graphic confirmation of familiar clinical observations. These may be summarized as follows:

1. RADICAL MASTOID OPERATION. The hearing loss of the ear subjected to the radical mastoid operation is severe, permanent, and even, with the passage of time, progressive. The loss averages 50 to 60 decibels for frequencies up to 2048, and 60 to 80 decibels for the higher frequencies. The clinical hearing was:

Acumeter	..	..	..	0"/36"
Whisper	..	..	..	0
Conversational voice	..	..	..	Very loud at contact only.

This hearing loss is so severe that there is no clinical difference pre- or post-operative, whether the operation cavity remains dry or moist.

2. This post-operative hearing loss *is not due to the radical mastoid operation per se*, but results from the underlying chronic otorrhœa which constitutes the indication for the radical operation. In this connection the average hearing loss in some 150 consecutive such cases (granulations, aural polypi and cholesteatoma) is shown to be almost as severe as that detected *after* the operation. The hearing loss is 40 to 45 decibels for the frequencies up to 2048, and 50 to 60 decibels for the higher frequencies. In the case of aural polypi, the loss is ten decibels higher. The clinical hearing was:

Acumeter	..	..	..	0"/36"
Whisper	..	..	..	0
Conversational voice	..	..	..	Up to 1 ft.

3. CORTICAL MASTOID OPERATION. The excellent hearing results secured by the cortical mastoid operation, where the otorrhœa ceases, the tympanic membrane heals over, becomes intact and normal in appearance (and the hearing in the other ear is normal). The average

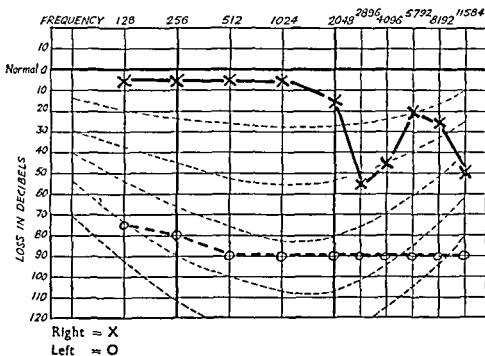
The Radical Mastoid Operation

impairment is but 15 decibels for the frequencies up to 4096, and 25 to 45 decibels for the higher frequencies. The clinical hearing was :

Acumeter 30"/36"
 Whisper 15 ft.
 Conversational voice .. 15 ft.

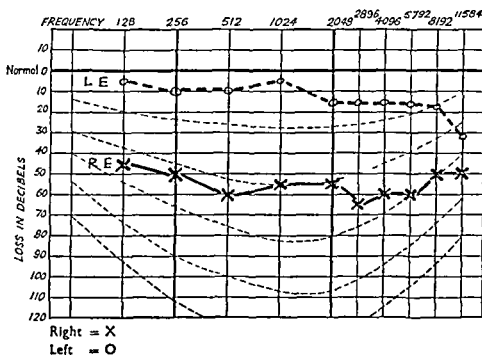
POST-OPERATIVE OTORRHOEA Typical Radical Mastoid Charts

Acumeter o"/36 Whisper o Loud shout not heard
 Left Radical Mastoid



AUDIOGRAPH A

Acumeter 8"/36 Whisper Loud *ad concham* Conversational voice Loud shout
ad concham
 Right Radical Mastoid



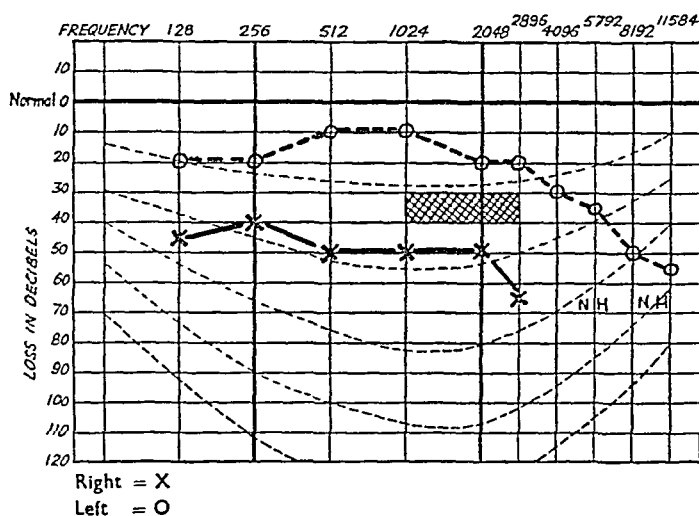
AUDIOGRAPH B

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TYPICAL AUDIOGRAPHS.

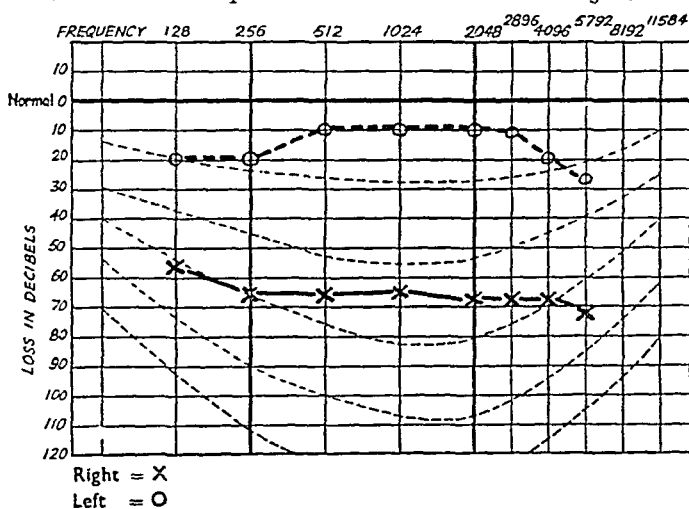
Pre- and Post-operative Chronic Otorrhœa.

N.R., age 50. Right Radical mastoid operation 11.2.48. Before operation: had chronic otorrhœa with cholesteatoma, and granulations for which a cortical operation had been performed.



AUDIOGRAPH C1

Three months after operation. Note deterioration of 15 decibels.



AUDIOGRAPH C2

On the contrary, where the *other* ear shows permanent defective hearing, and the tympanic membrane on the operated ear shows an attic scar, the hearing remains impaired even though the ear is dry. The

The Radical Mastoid Operation

hearing loss is 40 to 50 decibels for frequencies up to 2048, and 50 to 70 decibels for the higher frequencies The clinical hearing was

Acumeter	Contact
Whisper	2 ft
Conversational voice	2 ft

4 TUBO-TYMPANIC INFECTION The hearing in the cases of otorrhœa with the *large* permanent central perforation of the tympanic membrane (tubo tympanic) is in fact *better when the ear is discharging* than when the ear is dry The hearing is severely impaired in either case It averages 40 decibels, being higher for the higher frequencies (See Composite Audiograph 9)

5 The hearing loss is recorded of the ear after the discharge has dried up but with the small, dry, permanent central perforation of the tympanic membrane The loss averages 30-35 decibels for frequencies up to 2048, above which it rises to 60 decibels

6 HEALED OTORRHŒA The hearing loss is recorded in cases with a past history of otorrhœa with an intact membrane

7 OTHER CAUSES OF DEAFNESS Otosclerosis etc

The Radical Mastoid Operation, and the Hearing Loss

In the series there were some 409 consecutive cases Of these there were 479 ears with chronic otorrhœa During a period of three years these were all referred to me while ear consultant by a medical board There were amongst these, 37 in which the radical mastoid operation had been performed Out of these 8 were dry, and 29 were still discharging

The hearing loss is tabulated in decibels, (1) for the low tones and (2) for the high tones The hearing is taken to be defunct if the patient cannot hear at 70 decibel amplification

In almost every case the hearing loss was so great as to render the ear useless as an organ of hearing In 38 per cent (14 out of 37 cases) it was completely lost In 66 per cent the loss was almost complete

All the loss of hearing must not be ascribed to the radical mastoid operation *per se* If the usual standard indications for the operation are considered (chronic otorrhœa with granulations polypus, and/or cholesteatoma) and the pre operative depressed level of hearing ascertained, it is possible to assess what part, if any, is played by the radical mastoid operation in the causation of any deterioration of this pre-operative severe loss of hearing

TABLE IIA
THE RADICAL MASTOID OPERATION CAVITY
(52 cases in all)

A Relation to Persisting Discharge

SERIES A (Recruits)	36 cases	37 ears
Of the 37 ears	8 (22%)	were dry and healed
	29 (78%)	were still discharging
SERIES B (Cases seen in private)	16 cases	18 ears
Of the 18 ears	all	were dry and healed

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TABLE IIB

B. *Relation to Hearing Loss*

TOTAL EARS	37
Complete hearing loss	14 ears
Almost complete hearing loss	..	..	..	..	9 ears
					<u>23 ears, i.e. 66% of all ears.</u>
DRY, HEALED CAVITIES .. ..	..	..	..	..	8 ears
Complete hearing loss ..	..	..	..	..	4 ears
Almost complete hearing loss	..	..	..	..	1 ear
					<u>5 ears out of 8 ears, i.e. 60%.</u>
MOIST CAVITIES .. ..	..	..	..	..	29 ears
Hearing completely lost ..	..	..	..	..	10 ears
Almost completely lost	..	..	..	..	8 ears
					<u>18 out of 29 ears, i.e. about 66%.</u>

RADICAL MASTOID OPERATION CAVITY, DRY, HEALED

1. Patients, male, ages 17½ to 38. 8 cases. 8 ears.

SERIES A

Ages	Low tone loss	High tone loss
17 to 35	40 to 50 decibels	65 decibels

Five out of 8 cases had almost complete loss of hearing, i.e. 60 per cent.

Where the cavity is dry, the hearing is still severely affected. It may be completely lost (4 out of 8), 50 per cent., or almost completely lost (1 case).

The average loss for the low frequencies is 40 to 50 decibels; for higher frequencies the loss is 65 decibels.

2. Radical mastoid cavity, still discharging, ages 19 to 35.

Of patients, all male. 29 cases. 29 ears.

Age group	Total number of cases	Average low tone loss	High tone loss
17 to 20	13	50 to 55 db.	67 to 70 db.
21 to 30	7	57	60
31 to 40	9	50	60
Average		53 db.	65 db.

In 10 out of the 29 cases, the hearing was completely lost for all frequencies (33 per cent.).

In a further 9 cases, the hearing was almost completely lost, especially for the higher frequencies. The hearing is almost the same, whether the ear is dry or moist.

With less than 23 cases (66 per cent.) the hearing was completely destroyed, as the table shows. There is no relation between the duration of the otorrhœa and the degree of deafness, as over 50 per cent. of the cases were under the age of 20.

In one case originally included in this group, where good hearing was present, otoscopy revealed :

- (a) The operation cavity was dry.
- (b) The tympanic membrane intact.

The Radical Mastoid Operation

- (c) That a conservative operation or a cortical mastoid operation has been performed with permanent meatal drainage. This accounted for the good operative and functional result. The case was withdrawn from this series and included under cortical mastoid.

Thus the majority of cases (70 per cent.) subjected to the radical mastoid operation in hospital practice will continue to discharge and in nearly 100 per cent. will have no useful hearing.

It is necessary to know what the level of the hearing loss is in the case *before* the patient is subjected to the radical operation. We have these figures from a consideration of the results in chronic otorrhœa with granulations, polypi, or cholesteatoma. These are the cases, *par excellence*, in which the radical operation is indicated and performed.

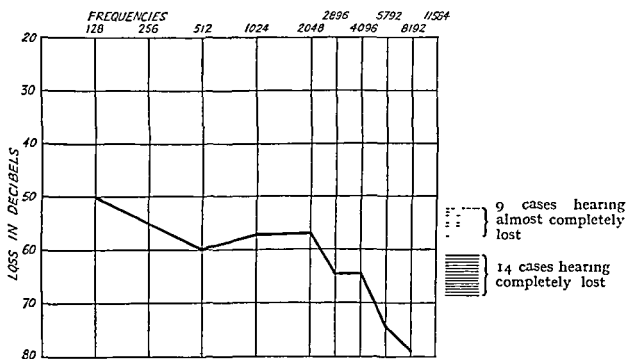
Composite audiograph 5 of the average loss in 153 cases shows a loss of 40-45 decibels for frequencies to 2048—above that from 50 to 70 decibels. In the radical mastoid cavity the loss is 55 to 65 respectively. (Composite Audiograph 2.)

The composite audiograph 2 shows a further loss of 15 decibels between the pre- and post-operative curve. The two curves are parallel—a remarkable coincidence. The further deterioration after the radical mastoid operation is 15 decibels, but clinically the difference is not detectable in view of the high pre-operative loss.

The Radical Mastoid Operation : The Post-operative Average Audiograph

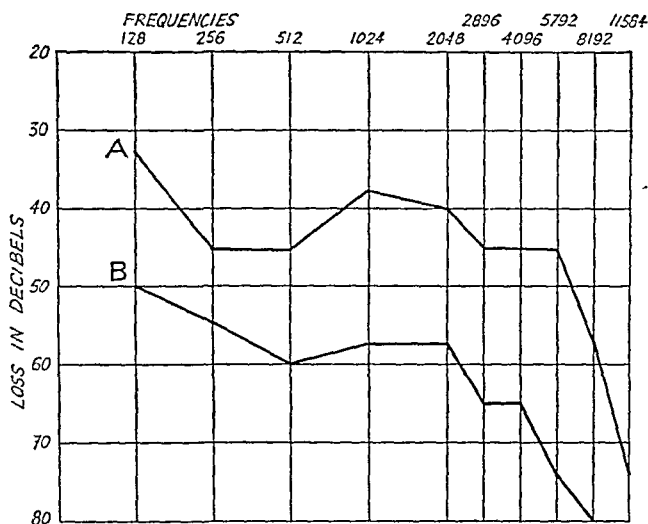
SERIES A

Composite audiograph of hearing after the radical mastoid operation, including 23 cases in which loss was total



COMPOSITE AUDIOGRAPH 1A.

N. Asherson



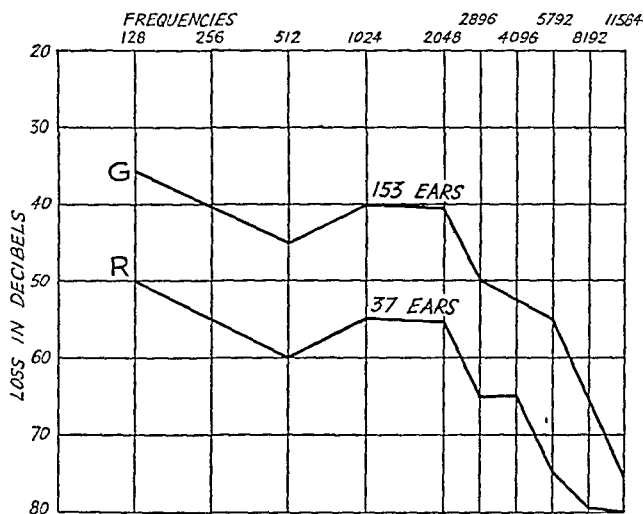
COMPOSITE AUDIOGRAPH 1B

ALTERNATIVE COMPOSITE AUDIOGRAPH OF 37 RADICAL MASTOID CASES

- A. The upper curve is that obtained from all the ears in which there is residual hearing, and *excluding* those cases in which the hearing is defunct. 14 ears.
 B. The lower curve is the composite for all cases as in chart. 37 ears.

The hearing loss after the radical mastoid operation ; 37 radical mastoid cavities (29 moist, 8 dry).

The curve A composite audiograph 1, shows average hearing loss in 37 cases, including 14 in which hearing was completely lost for all frequencies and 9 cases in which hearing was *almost* lost.



COMPOSITE AUDIOGRAPH 2

Composite audiograph to show :

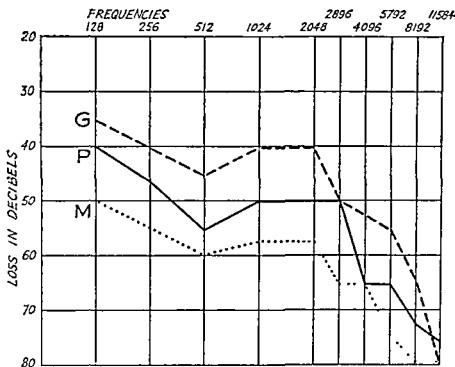
1. Pre-operative hearing loss (153 ears with granulations).
2. Post-operative hearing loss after the radical mastoid operation (37 ears).

R=Radical cavities.

G=Granulations.

The Radical Mastoid Operation

In the shaded area, each straight line represents one of the 14 cases in which hearing was completely lost (50 per cent. at 90 decibel level). Each interrupted line represents one of the 9 cases in which hearing was *almost* lost.



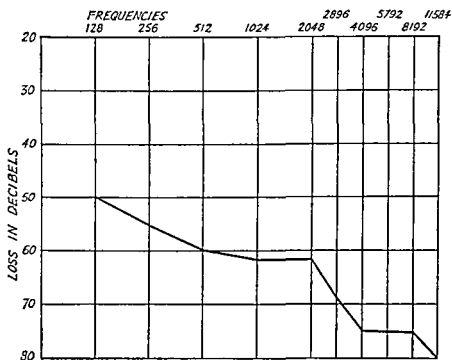
COMPOSITE AUDIOGRAPH 3

Composite audiograph Pre-operative and post-operative hearing loss, showing the loss for granulations and for polypi

G=Curve of chronic otorrhœa with granulations (153 ears)

P=Curve of chronic otorrhœa with polypi (38 ears)

M=Curve of chronic otorrhœa after radical mastoid operation (37 ears).



COMPOSITE AUDIOGRAPH 4

Contrast of post-operative audiograph of 18 radical mastoid operations (Seen in private in the last two years)
18 ears All dry cavities

Contrast Series of Radical Cavities : Cases seen Privately

In private practice in the limited number of cases which present, the radical cavity can always be healed if the after-care remains continuously in the hands of the operator. The hearing effect, however, is the same.

The audiograph shows the average hearing loss in 18 radical mastoid cavities (the operation being performed in the past in private by various otologists) *whose after-care was in the hands of the operator until healed*. These were consecutive cases seen in the past two years, *and every cavity was dry, healed, and remained so*. The hearing loss, however, was no better than in the previous series. In 7 out of the 18 (about 40 per cent.) the hearing was completely lost in the operated ear, the loudest shout *ad concham* only being perceived ; in the bilateral case, an air conduction hearing aid was effective.

The complete loss occurred in the twenty-year-old as well as in the octogenarian (age 85).

Alternative Statistical Method of Determining the Composite Audiograph Chart for Radical Cavities

In the cases with the radical mastoid operation, the hearing may be classified into three categories :

1. Those with good or almost normal hearing. There was only one such case (Case 33) out of 52.

2. Those in which the hearing is completely defunct, i.e. a loud shout *ad concham* is barely perceived when the other ear is occupied by a noise. There were 23 in the series of 37 ears.

3. Excluding those cases in categories 1 and 2 there is the residue of 14 ears in which there is *some* hearing. If these cases *alone* are averaged, we get the chart shown.

Audiograph curve 1 shows the losses being 10 to 15 decibels less than the average for all ears (the radical mastoid operation). The loss is 40 to 45 decibels for all frequencies to 5792 and 50 to 65 decibels for higher frequencies.

The practical application is the following :

A. Either the hearing is totally lost ;

B. If there *is* hearing, then it is probable that the hearing loss is of the order given in this curve A, Composite audiograph 1.

Prophylaxis. These statistics make depressing reading. Can anything be done to relieve this doleful picture ?

Chronic otorrhœa, of the type requiring the radical operation, is a disease of the economic poor, and does not exist in the better economic strata of society. These statistics apply chiefly to the stratum of the population in which it is particularly rife. Pre-war there were over 4,000 cases of active chronic otorrhœa in the school population of London (1 per cent. in all)—a disgrace which the L.C.C. has always been alive to and was successfully coping with.

The Radical Mastoid Operation

TABLE 3

RADICAL MASTOID CAVITIES

Comparison of Audiometer, Acumeter and Voice Tests

Acumeter is normally heard up to 35° Whispered and conversational voice maximum distance recorded is 15' NH—Not heard with the frequency amplified to 80 decibels a c—*Ad concham*

The italics indicate a case with some detectable hearing

36 cases

37 ears

8 dry

GROUP I AGES 17-20 YEARS

A Moist Cavity

Case	Age	Ear	Frequencies										Acumeter	Whispered voice	Conversational voice
			128	256	512	1024	2048	2896	4096	5792	8192	11584			
1	17½	L	NH	NH	NH	NH	NH	NH	NH	NH	NH	NH	0°	0°	Not heard, with other ear occupied
9	19	R	45	50	60	55	55	65	60	60	50	50	8°	0°	Loud a c
10	19	R	55	70	70	70	60	NH	70	NH	NH	NH	NH	NH	Not heard
13	17	R	35	45	45	NH	60	60	60	NH	NH	NH	0°	0°	1', with other ear occupied
15	19	R	40	NH	60	60	60	60	60	NH	NH	NH	0°	0°	Loud shout not heard
22	18	L	10	20	35	15	30	25	30	50	60	60	6°	3'	4'
23	17½	L	45	50	50	NH	NH	NH	NH	NH	NH	NH	0°	0	Loud shout not heard
24	18½	R	20	30	34	34	40	30	20	20	35	40	0°	0°	3', with other ear occupied
25	19	R	50	55	65	45	40	60	65	60	65	60	0°	0	Loud a c
26	20	L	40	45	50	45	45	60	50	55	40	50	0°	0	1'
32	18	L	35	50	65	60	60	70	65	70	NH	NH	0°	0°	Shout, with other ear occupied
34	18½	R	40	50	60	40	45	45	60	60	60	60	0°	0°	a c, with other ear occupied
33	19	L	20	25	35	25	20	20	65	60	70	70	2°	8	12'

B Dry Cavity

5	19	R	NH	50	65	NH	NH	NH	NH	NH	NH	NH	0°	0°	Loud shout not heard
6	17½	R	30	50	35	30	25	60	45	65	65	65	6°	1'	5
7	18	L	35	45	50	30	60	45	50	45	45	NH	3°	3'	6
36	18	R	NH	65	NH	NH	NH	NH	NH	NH	NH	NH	0°	0°	0', with other ear occupied
8	19	R	45	50	55	60	55	50	50	70	70	70	0°	0	0'
39	18½	R	35	50	55	55	45	45	45	55	65	65	0°	0	0

GROUP II AGES 21-30 YEARS

A Moist Cavity

14	25	R	45	50	40	45	55	55	40	55	NH	NH	6°	1'	3
22	22	L	60	65	60	55	60	70	65	45	70	NH	0°	0°	Loud shout with other ear occupied
22	29	R	45	NH	60	55	55	40	50	45	45	50	10°	0	2 only, with other ear occupied
27	28	L	NH	40	65	55	55	55	55	55	65	65	0°	0	1 ft with other ear occupied
28	29	R	60	65	60	NH	NH	NH	NH	NH	NH	NH	0°	0°	Loud shout 1
38	28	R	45	65	60	55	50	45	45	40	50	65	0°	a c only	1'
35	30	R	45	55	65	45	35	50	35	35	45	45	3°	1'	1'

GROUP III AGES 31-40 YEARS

A Moist Cavity

2	35	R	25	30	30	30	25	40	40	65	70	70	6°	2	6
11	32	R	35	45	55	35	40	50	60	NH	NH	NH	0°	0	Loud shout not heard with other ear occupied
16	36	R	35	45	40	35	45	NH	65	60	70	70	8°	1	1'
17	35	L	35	30	50	45	55	60	60	60	70	NH	0°	0°	Loud shout a c
18	35	R	35	40	35	25	20	35	35	35	40	40	6°	1'	2
19	39	L	20	60	60	55	70	NH	NH	NH	NH	NH	0°	0	Loud shout a c
21	34	R	60	NH	NH	NH	NH	NH	NH	NH	NH	NH	0°	0	0, with other ear occupied
30	34	R	20	25	20	20	15	35	25	20	25	50	0°	0	a c
31	33	R	60	NH	NH	NH	NH	NH	NH	NH	NH	NH	0°	0	Loud shout a c

B Dry Cavity

2	35	L	30	35	50	40	30	35	45	45	60	70	6°	5	10
4	40	L	75	NH	NH	NH	NH	NH	NH	NH	NH	NH	0°	0	Shout not heard

Table of 37 radical mastoid cavities to show:

- Audiograph loss
- Clinical loss
- State of ear—moist or dry

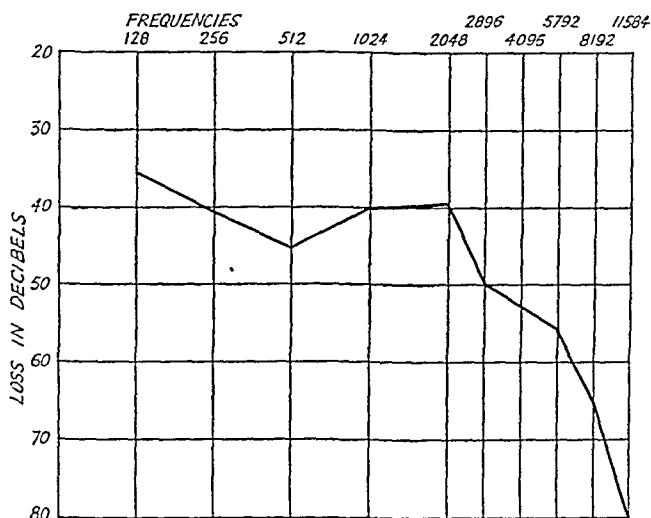
Classified in age groups

2. *Category B.* There were 4 cases, 6 ears (i.e. 2 bilateral). The ear was dry ; there was an attic perforation ; or the other ear was deaf ; or there was marked nasal sepsis ; or large central permanent perforation of the tympanic membrane. (In one case the bilateral cortical operation was performed in infancy.) In these cases, the loss exceeded 30 decibels, the average loss being for the low tones, 40 decibels—for the high tones, 50 decibels. (See Audiograph E 2.)

Chronic Otorrhœa with Granulations and/or Cholesteatoma (excluding Polypi)

Chronic suppurative otorrhœa with granulations (and cholesteatoma). 153 ears (cases).

In 24 ears the hearing loss was severe.



COMPOSITE AUDIOGRAPH 5

There were 153 cases, none of them operated upon.

The granulations are associated with a marginal perforation.

In 24 cases (16 per cent.) the hearing loss was very severe (over 60 decibels for all frequencies) but the average loss, as depicted in the composite audiograph, is 40 decibels for the frequencies up to 2048, and up to 80 decibels for the higher frequencies.

The composite audiograph of cases *after* the radical mastoid operation show no improvement in the hearing. On the contrary it shows a further 15 decibels deterioration. (Composite audiographs 2 and 3.)

Granulations which arise from the *wall* of the meatus or from the margins of a *central* perforation are not included in this category. These

The Radical Mastoid Operation

are cases which one would expect to respond to conservative treatment in almost 100 per cent of cases This is mentioned as some authors erroneously lump all cases together *

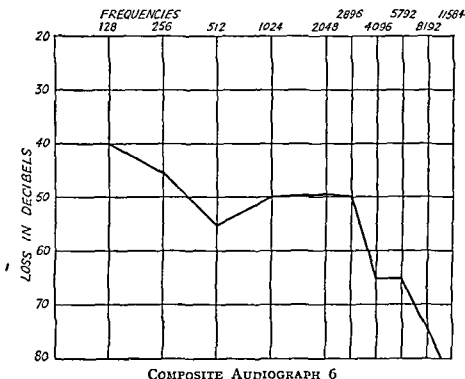
Aural Polypi

There were 37 cases, 38 ears

In every case the radical mastoid operation was indicated, the hearing was severely affected The level of loss for the lower frequencies never rose above 30 to 35 decibels The average loss was 60 to 80 decibels The high tone loss was a constant feature of every case

When composite audiographs are made of the average loss of hearing in cases of chronic otorrhœa (1) with granulations, (2) with polypi, and (3) after the radical operation, it will be observed that the hearing loss is more marked when a polypus is present, and is still more marked after the radical operation (Composite audiograph 3)

AURAL POLYPI
38 ears
Composite audiograph



* Banham T M 'The Conservative Treatment of Chronic Suppurative Otitis Media in Adults' *J Laryng and Otol* 1944 ix 117

N. Asherson

Aural polypi—unoperated on. 37 cases. 38 ears. 11 with completely defunct hearing, i.e. 29 per cent.

The audiograph curve: average hearing for 38 ears *including* the 11 cases in which the hearing was completely lost, and assessed at a 90 decibel loss for purposes of computation.

TABLE 4

COMPARISON OF AUDIOMETER, ACUMETER AND VOICE TESTS

Acumeter is normally heard up to 36". Whispered and conversational voice with maximum distance recorded is 15'.

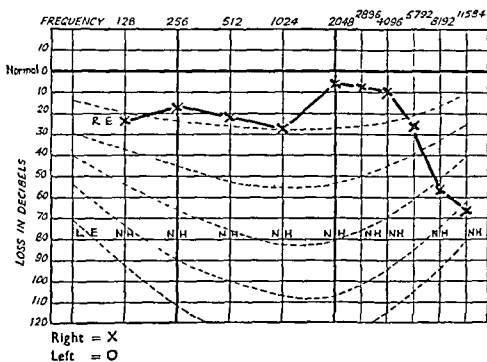
w.o.e.n.—with other ear occupied by a noise. a.c.—*ad concham*.

A. Aural Polypi: Total 39 Ears

Case	Age	Ear	Frequencies										Acumeter	Whispered voice	Conversational voice
			128	256	512	1024	2048	2896	4096	5792	8192	11584			
1	19	L	25	25	25	20	20	30	40	50	55	60	0"	8'	12-15'.
2	33	R	40	50	55	50	35	55	55	40	60	70	0"	0'	Loud at 1'.
4	33	R	25	20	25	25	5	10	10	25	55	65	0"	15'	12'?
5	32	R	50	50	60	65	70	80	70	65	60	70	0"	2'	1' w.o.e.n.
6	40	R	20	30	40	25	25	50	60	60	65	NH	0"	1'	5' tort.
7	39	R	45	55	55	65	65	65	NH	75	NH	NH	0"	0'	Loud shout w.o.e.n. at contact.
8	39	L	50	70	80	75	75	85	NH	NH	NH	NH	0"	0'	Loud shout NH a.c.
9	38	L	40	55	65	60	60	65	80	NH	90	NH	0"	NH	NH.
10	36	R	35	50	70	75	80	85	NH	NH	NH	NH	0"	0'	Loud shout at contact.
11	31	L	25	50	45	50	50	60	50	45	70	70	0"	1'	1' w.o.e.n.
12	42	R	30	35	35	30	30	50	60	55	70	85	0"	Contact only	3' only.
13	16½	R	35	50	45	35	25	30	60	45	60	50	12"	At contact	1'.
14	18½	L	40	45	45	60	65	60	60	55	55	65	0"	0'	1'.
15	33	L	45	55	NH	60	60	65	60	60	70	75	0"	0'	Loud shout at contact.
17	34	L	45	60	55	55	40	55	50	60	70	75	0"	0'	Loud shout at contact.
18	32	L	30	50	65	50	60	65	80	65	65	NH	0"	0'	Loud shout at contact.
19	39	L	35	50	55	35	60	65	55	70	75	NH	0"	2'	7'.
20	32	L	25	25	25	25	45	50	55	45	65	NH	Contact	2'	3'.
21	29	R	35	40	35	30	30	30	20	30	45	45	6"	3'	10'.
23	30	R	25	30	35	25	20	25	30	30	45	NH	10"	12'	12'.
24	33	R	30	35	35	35	35	55	60	NH	70	70	4"	14'	14'.
25	30	R	30	30	30	30	35	35	45	50	60	70	Contact	2'	w.o.e.n.
27	40	L	40	45	55	45	55	50	60	50	60	70	0"	0'	Loud at contact w.o.e.n.
29	37	R	40	40	40	35	35	70	55	55	60	NH	0"	0'	Loud shout w.o.e.n.
30	42	R	50	45	45	20	35	60	NH	70	65	70	0"	1'	1'.
31	40	L	30	35	30	30	50	40	60	NH	NH	NH	0"	0'	1'.
32	39	R	30	50	55	45	65	50	65	70	NH	NH	0"	0'	Contact w.o.e.n.
33	43	L	40	55	50	35	30	25	30	40	50	NH	6"	3'	4'.
34	35	R	10	15	25	25	45	55	70	NH	75	NH	0"	8'	14'.
35	34	L	40	35	45	30	20	35	35	20	25	45	20"	3'	5'.
37	38	L	25	25	25	25	25	45	65	NH	NH	NH	0"	8'	15' only.
38	18	L	15	25	20	50	50	40	30	40	60	NH	6"	1'	1'.
3	33	L	NH	NH	NH	NH	NH	NH	NH	NH	NH	NH	0"	0'	Loud shout at contact.
16	35	R	80	NH	NH	NH	NH	NH	NH	NH	NH	NH	0"	0'	Stone deaf.
17A	34	R	65	65	NH	NH	NH	NH	NH	NH	NH	NH	0"	0'	No shout at contact w.o.e.n.
22	31	L	45	NH	NH	NH	NH	NH	NH	NH	NH	NH	0"	0'	Loud shout only w.o.e.n.
26	36	L	45	65	NH	75	NH	65	—	—	—	—	0"	0'	Loud shout at contact w.o.e.n.
28	34	R	60	65	75	75	80	NH	NH	NH	NH	NH	0"	0'	0' w.o.e.n. at contact.
36	20	R	30	60	60	to opposite ear							0"	NH	Loud at contact.

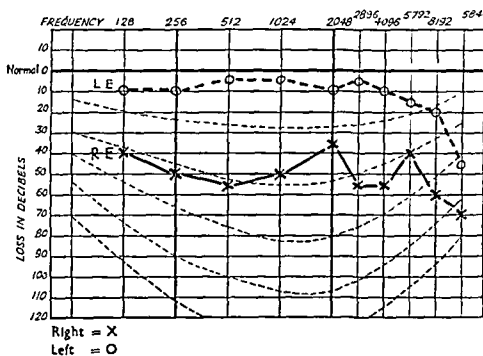
The Radical Mastoid Operation

TYPICAL AUDIOGRAPHS, AURAL POLYPI



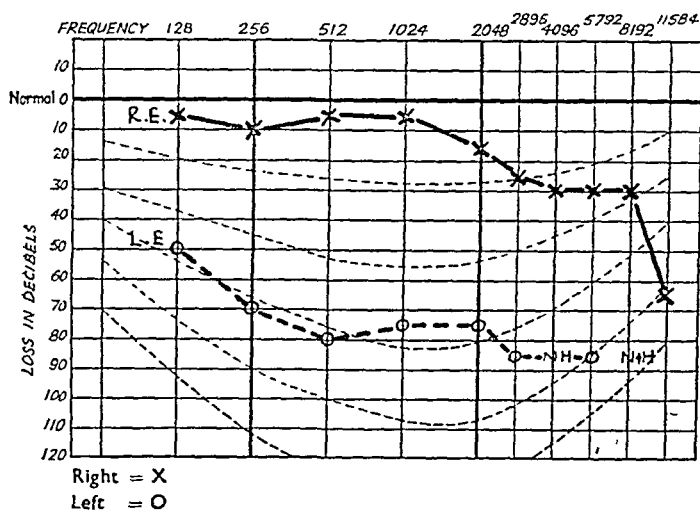
AUDIOGRAPH F1

POLYPI



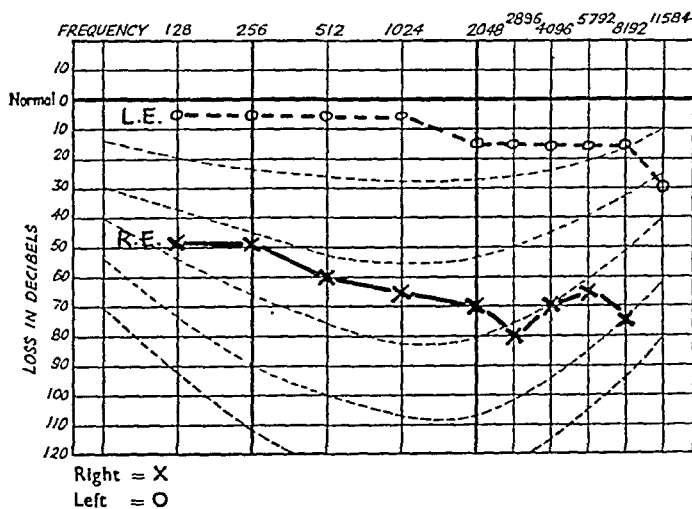
AUDIOGRAPH F2

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AUDIOGRAPH F3

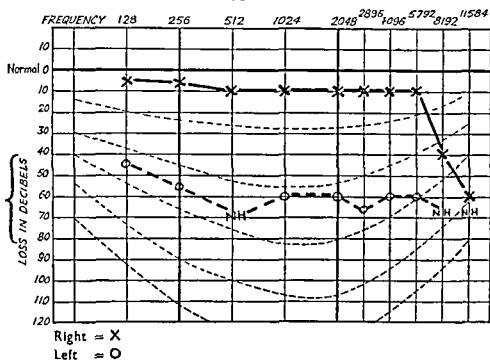
POLYPI.



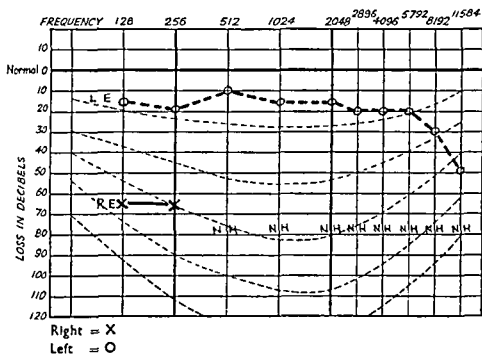
AUDIOGRAPH F4

The Radical Mastoid Operation

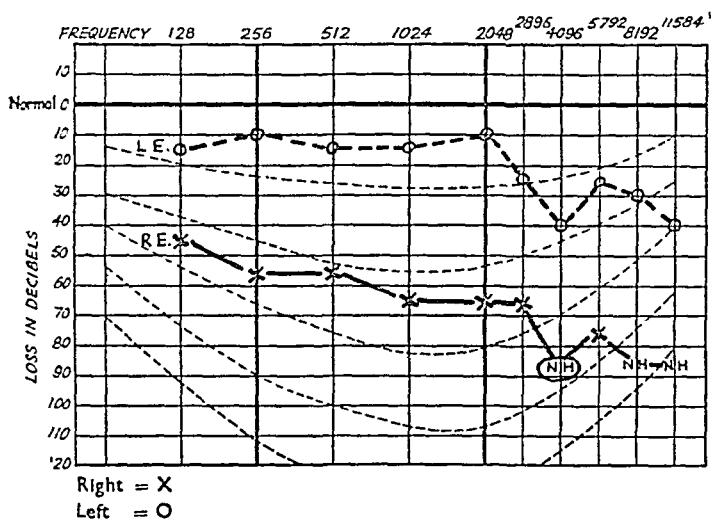
AURAL POLYPL.
Typical.



AUDIOGRAPH F5



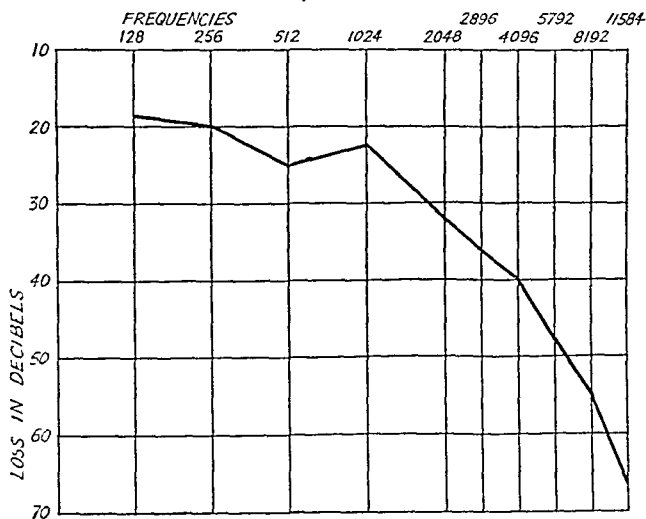
AUDIOGRAPH F6



Sub-Acute Otorrhœa and the Audiograph

SUB-ACUTE OTORRHŒA.

14 ears.



There were 12 cases (14 ears) of sub-acute otorrhœa—otorrhœa of recent onset and the average hearing loss is given. All cases were those which might be expected to resolve with conservative treatment. In two cases, audiographs are available during the attack and after the discharge had ceased.

The Radical Mastoid Operation

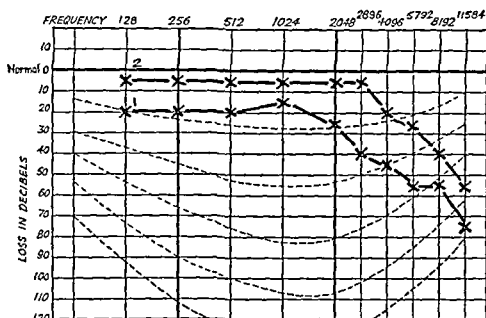
The hearing loss is slight for the lower frequencies, being 20 to 25 decibels up to 2048 and 30 to 55 for the higher frequencies.

With the resolution of the otorrhœa, the hearing is improved. This is shown in the two cases recorded below.

Two cases of acute otitis media (abstracted from previous table) to show recovery in hearing with subsidence of the infection.

ACUTE OTITIS MEDIA.

Age 37. Right Ear

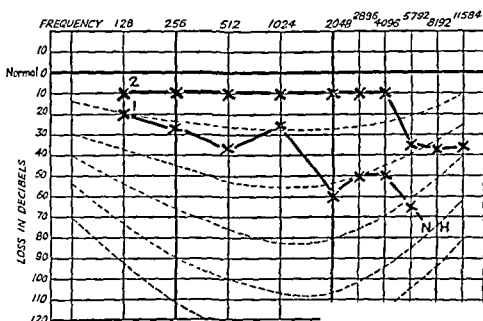


Right = X¹ - BEFORE 31.3 42
Right = X² - AFTER 14 5 42

AUDIOGRAPH G1

ACUTE OTITIS MEDIA

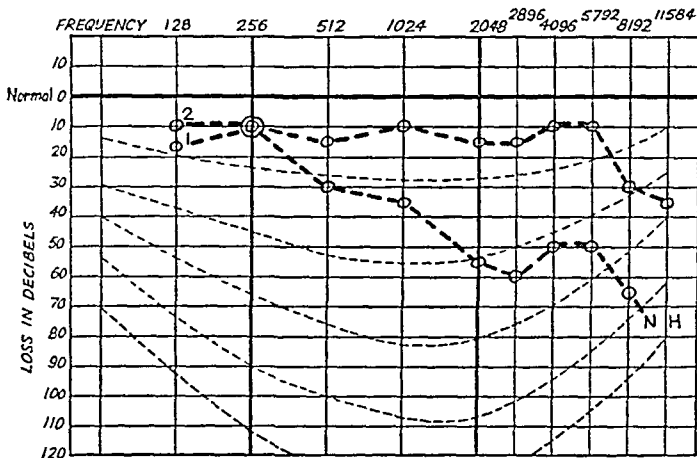
Age 18. Right and Left Ears Before and After



Right = X¹ - BEFORE 5.2 43
Right = X² - AFTER 1.5 43

AUDIOGRAPH G2

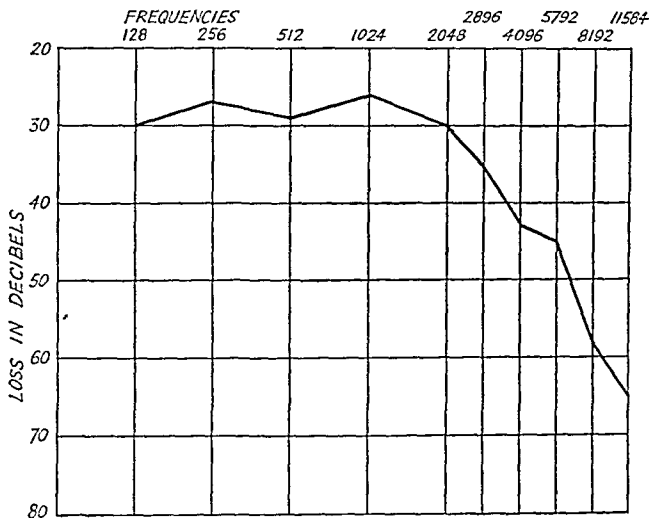
N. Asherson



AUDIOGRAPH G3

Attic Disease. Chronic Otorrhœa

ATTIC DISEASE.
30 cases.



COMPOSITE AUDIOGRAPH 8

There were 30 cases in which the disease was confined to the attic region.

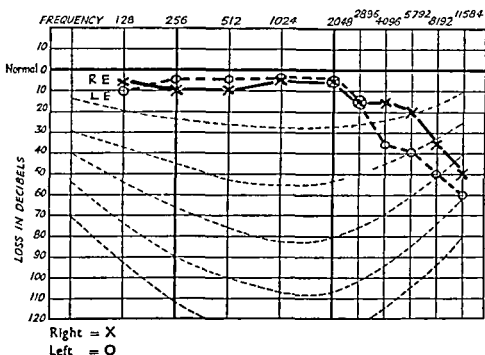
The composite audiograph shows a uniform loss of hearing of 25 to 30 decibels up to 2048, above which it varies from 25 to 65 decibels increasing progression.

The Radical Mastoid Operation

ATTIC

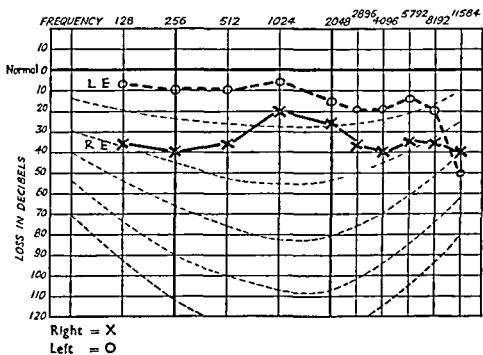
Age 28

Acumeter 5" Whisper 15' Conversational voice 15'



AUDIOGRAPH H1

Acumeter 12" Whisper 1' Conversational voice 1'



AUDIOGRAPH H2

Tubo-Tympanic Infection

Permanent Perforation of the Tympanic Membrane

This is manifest by a permanent (partial or complete) central perforation of the tympanic membrane. It is always a benign form of relapsing chronic otorrhœa, which invariably responds promptly to suitable conservative treatment.

Clinically, the cases are divided into :

1. *Large complete permanent central perforation*, i.e. involving the entire tympanic membrane. The ear may be (a) dry, (b) moist.
2. *Small partial permanent central perforation*, i.e. involving only part of the tympanic membrane—usually an area not exceeding one quadrant. The ear may be (a) dry, (b) moist.

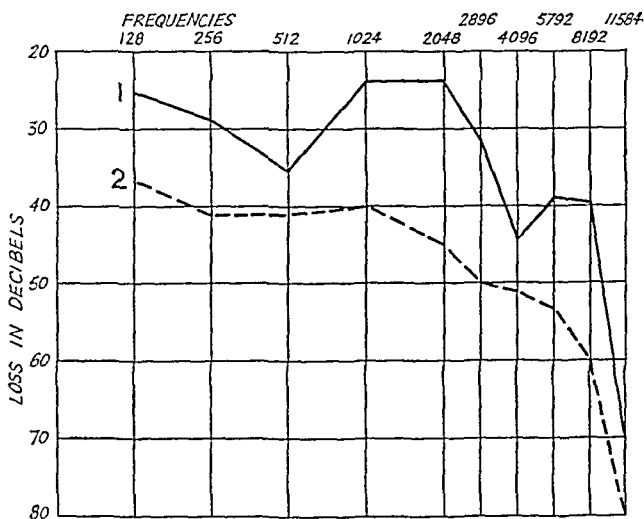
Relapsing Chronic Otorrhœa, associated with a Permanent Central Perforation of the Tympanic Membrane (Tubo-Tympanic)

There is obviously no relation between the membranal perforation, *per se*, and the extent of the hearing loss, either during the period the ear is discharging, or when it is dry. These statistics are submitted to indicate the extent of the loss for the various frequencies, in a series of consecutive cases.

The hearing loss depends upon the severity and the extent of the original infection and otorrhœa as well as any subsequent relapses.

COMPLETE PERMANENT CENTRAL PERFORATION OF THE TYMPANIC MEMBRANE. Composite audiograph.

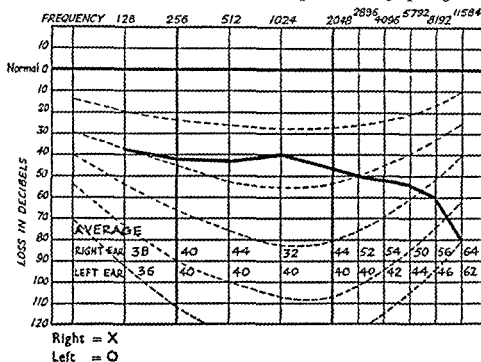
1—Moist ears. 2—Dry ears.



COMPOSITE AUDIOGRAPH 9

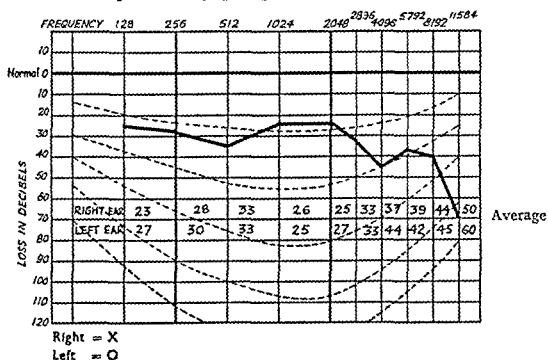
The Radical Mastoid Operation

Bilateral complete permanent central perforation of the tympanic membrane. Ear dry. 5 patients 10 ears. Averages for each ear. Composite audiograph right and left ears.



COMPOSITE AUDIOGRAPH 9A

Bilateral complete permanent central perforation Ear moist 8 patients 16 ears. The average loss for the right and for the left ears are given below, for comparison Composite audiograph, right and left ear



COMPOSITE AUDIOGRAPH 9B

In the entire series I have failed to record a *normal* hearing when the perforation has been due to infection of the middle ear, though in a traumatic case (see composite audiograph 10) I have encountered normal hearing.

A central perforation of the tympanic membrane is a manifestation of

N. Asherson

a benign type of otorrhœa, which never becomes complicated, and rarely, if ever, requires a mastoid operation. It is always associated with a nasopharyngeal infection, particularly a homolateral infection of the maxillary antrum.

A series of cases with bilateral *permanent complete* central perforations of the tympanic membrane are attached.

1. With the ears dry: 5 patients, 10 ears. (Composite audiographs 9, 9a, 9b.)

2. With the ears discharging: 8 patients, 16 ears.

These confirm a clinical observation made spontaneously by the patient that he hears better when the ear is moist. This applies to this category only.

TABLE 5

BILATERAL PERMANENT CENTRAL PERFORATION OF THE TYMPANIC MEMBRANE. THE EAR IS DRY

Case	Name	Age	Ear	Frequencies											Acumeter	Whispered voice	Conversational voice
				128	256	512	1024	2048	2896	4096	5792	8192	11584				
1	W.M.	43	R	30	25	25	20	NH	at 70					Contact	1'	5'	
			L	35	55	55	NH	at 70						0'	0'	1'	
2	R.B.	18	R	40	40	45	30	30	30	45	30	35	50	10'	10'	5'	
			L	20	10	10	10	15	15	15	30	25		36'	15'	15'	
3	R.T.	42	R	35	35	45	25	30	45	55	60			6'	14'	12'	
			L	40	45	45	40	35	35	35	45	55	60	6'	3'	5'	
4	E.W.P.	37	R	40	50	55	50	40	50	40	35	50	60	10'	5'	1'	
			L	35	40	50	45	45	35	35	30	45	60	6'	Contact	1'	
5	D.F.S.	40	R	45	55	50	50	55	65	60	50	55	NH	6'	3'	5'	
			L	50	55	45	30	30	40	50	45	40	50	6'	2'	3'	

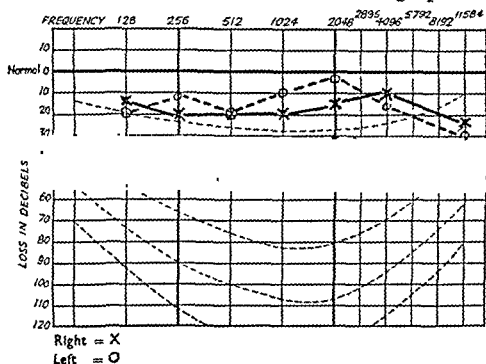
TABLE 6

MOIST BILATERAL PERMANENT CENTRAL PERFORATIONS

Case	Name	Age	Ear	Frequencies											Acumeter	Whispered voice	Conversational voice
				128	256	512	1024	2048	2896	4096	5792	8192	11584				
1	E.G.W.	18	R	10	25	25	20	20	15	30	15	15	15	Normal 36"	8' 5' 6' At contact	12' 5' 1'	
2	J.D.	28	L	35	40	45	35	35	35	20	20	20	50	30"			
3	E.M.	18	R	30	35	40	35	25	55					0"	18' 8' 8' 15' 15' 8' 12' 15' 6'	3' 3' 5' 10' 15' 6'	
4	C.F.P.	31	L	30	30	35	20	15	20	50	50	50	10"				
5	S.B.	18	R	30	45	50	40	40	40	40	35	40	10"	24" 30" 4" 36" 10"	15' 15' 8' 15' 12'	15' 15' 6'	
6	W.E.B.	41	L	25	25	20	15	40	35	50	40	35	24"				
7	V.R.	19	R	5	5	5	5	5	20	25	25	20	25	30"	15' 15' 8' 15' 15' 15' 15'	10' 15' 15' 15'	
8	E.	31	L	25	25	30	10	15	25	50	40	45	55	4"			
			R	15	25	45	30	25	55	40	55	35	50	36"	12' 15' 36" 36"	12' 15' 15'	12' 15'
			L	20	20	20	20	20	40	50	60	60	60	10"			
			R	10	10	20	15	15	15	25	25	55	45	36"	15' 1'	15'	6-8'
			L	20	20	20	20	35	30	30	25	35		36"			
			R	30	25	30	25	25	35	40	50	50	50	2"	Contact	3'	
		Dry	L	30	45	50	40	30	25	35	30	45	35	6"			

The Radical Mastoid Operation

Traumatic Perforation and the Audiograph



COMPOSITE AUDIOGRAPH 10

Box on the ears producing perforation, dry central, of the tympanic membrane without affecting the hearing.

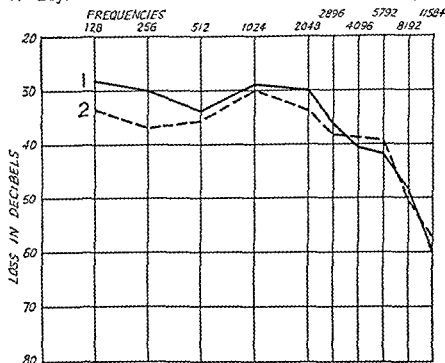
Female, age 20, received a blow on the ear three days previously. There was no hæmorrhage, but the only symptom she complained of was a whistling in the ear when she blew her nose. The perforation was postero-superior, central and dry. There was no otorrhœa. Note that the hearing has not been affected to any extent.

The Hearing Loss of the Discharging and the Dry Ear

COMPOSITE AUDIOGRAPH OF ALL PERMANENT CENTRAL PERFORATION (Large and Small)

1. Dry.

2. Discharging



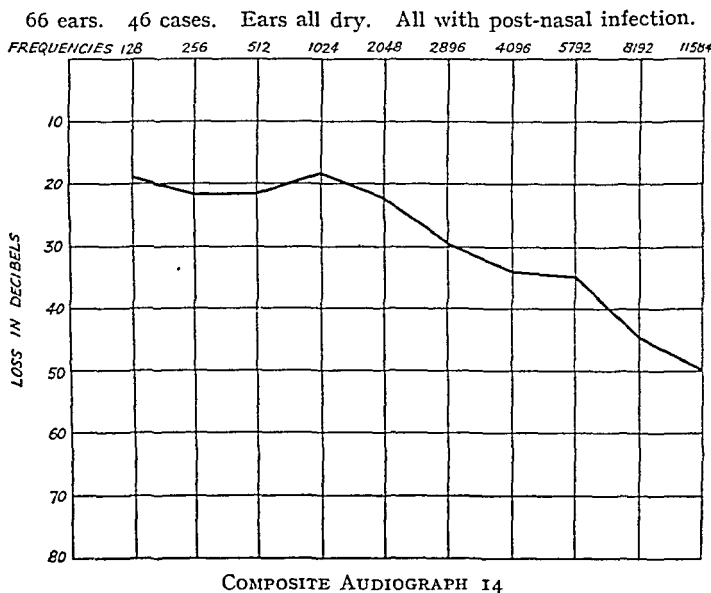
COMPOSITE AUDIOGRAPH 11

The Audiograph of the Dry Healed Ear after Chronic Otorrhœa in the past

There were 46 cases with 66 ears.

This series included cases with a past history of otorrhœa, usually chronic and sometimes relapsing. Their ears were dry, and in every case the tympanic membrane was intact, but often showed deformities, e.g. old healed perforations, scars, etc.

The composite audiograph shows the average loss of 20 decibels for the frequencies up to 2048; above this the loss is 30 to 50 decibels.



Abnormal Otoscopic Findings and the Audiograph

There were 35 ears.

In this series there were deformities, displacements, and adhesions of the intact healed tympanic membrane.

A table is given of the otoscopic picture, the audiograph and the clinical tests of hearing. It will be observed that there is no relation between the hearing impairment and the otoscopic findings.

Post-Nasal Sepsis ; Sinusitis ; Post-Nasal Catarrh. (Permanent Central Perforations, partial or Complete)

It is well known that tubo-tympanic infection is caused by, or kept going by, nasal and post-nasal sepsis.

In no less than 67 out of 76 of these cases there were symptoms and signs of post-nasal catarrh, and sinusitis. In many cases the maxillary antrum was more opaque on the side of the discharging ear. Of the

The Radical Mastoid Operation

Case	Age	Ear	Frequencies										Acumeter	Whisper	Conversational voice	Remarks
			128	256	512	1024	2048	2896	4096	5792	8192	11584				
4	34	L	20	15	15	10	15	35	25	20	40	45	Normal	15'	Normal	no of left membrane, rane indrawn and retracted, rane indrawn and retracted
5	7	R	20	25	45	25	30	20	35	30	30	30	Normal	5'	---	canes indrawn and adherent to
6	39	L	15	10	5	5	5	5	15	25	35	50	Normal	---	---	tus in childhood
8	17	R	25	25	25	25	25	30	55	30	30	60	Normal	Normal	---	nic membrane which is indrawn
9	19	R	10	10	10	10	10	20	35	35	35	40	Normal	---	---	na and Shrapnell's membrane,
10	30	R	5	5	5	5	25	20	25	20	35	45	Normal	---	---	a the latter part resembles a
11	30	L	10	10	10	5	5	15	5	10	35	45	Normal	---	---	huned, indrawn and adherent to
14	37	L	30	25	25	25	25	20	15	20	40	60	Normal	---	---	al articulation,
15	18	R	5	5	15	10	10	20	15	20	20	30	Normal	---	---	are shows healed old perforation
16	37	R	20	15	10	10	15	15	30	45	60	70	Normal	Normal	---	oration, central
19	26	R	20	5	15	10	15	15	15	15	25	60	Normal	---	---	brane is intact, indrawn and
21	47	R	10	10	10	10	10	10	35	20	45	60	Normal	Normal	---	d scar. Relapsing otorrhea,
22	36	L	10	10	10	10	20	20	30	15	50	75	Normal	12'	Normal	rane are indrawn and scarred
24	36	R	20	30	25	15	25	35	20	30	40	40	Normal	---	---	ic membrane shows a healed scar.
26	37	R	40	45	45	35	55	60	65	NH	NH	NH	6'	1'	5'	ic membranes show old healed perforations.
30	40	L	20	20	25	20	25	30	45	40	45	60	6'	5'	12'	brane indrawn. Left otorrhea in past.
36	26	L	10	15	10	10	15	20	20	20	30	35	20'	15'	Normal	membrane is scarred, indrawn, healed
35	18	R	10	10	10	10	10	10	10	35	35	35	Normal	---	---	s opacities.
33	26	L	15	15	15	20	20	15	55	40	40	50	36'	12'	---	ry, and the tympanic membrane thinned
41	26	L	25	45	45	50	30	30	35	55	60	65	Normal	---	---	a, old, healed perforation.
42	19	R	20	20	50	45	40	20	25	35	40	45	8'	4'	5'	membranes indrawn and adhered to the
43	19	R	35	35	30	30	35	55	55	NH	NH	NH	12'	8-10'	3'	if the middle ear.
49	7	R	20	20	35	20	25	35	40	45	45	70	6'	4'	5'	ic membrane is indrawn and his bearing
50	18	L	20	25	30	25	25	30	25	35	35	35	Normal	---	---	r membrane is indrawn and is plastered
51	18	R	25	20	20	25	25	30	25	35	35	35	Normal	---	---	ic membrane shows a healed postero-
57	34	L	20	20	20	5	15	35	30	25	45	55	Normal	---	---	ration, the tympanic membrane being
61	18	L	25	15	25	20	15	15	15	20	20	20	25'	10'	---	, the incudo stapedial articulation. The
62	19	L	10	10	10	10	25	25	25	25	25	40	Normal	---	---	could be clearly seen. Ear dry. Left
													Normal	---	---	membrane shows old healed perforation
													Normal	---	---	ic membrane
													Normal	---	---	c membranes are indrawn and the left
													Normal	---	---	aled perforation.
													Normal	---	---	ic membrane indrawn.
													Normal	---	---	membrane is indrawn and presents an
													Normal	---	---	appearance in the attic.

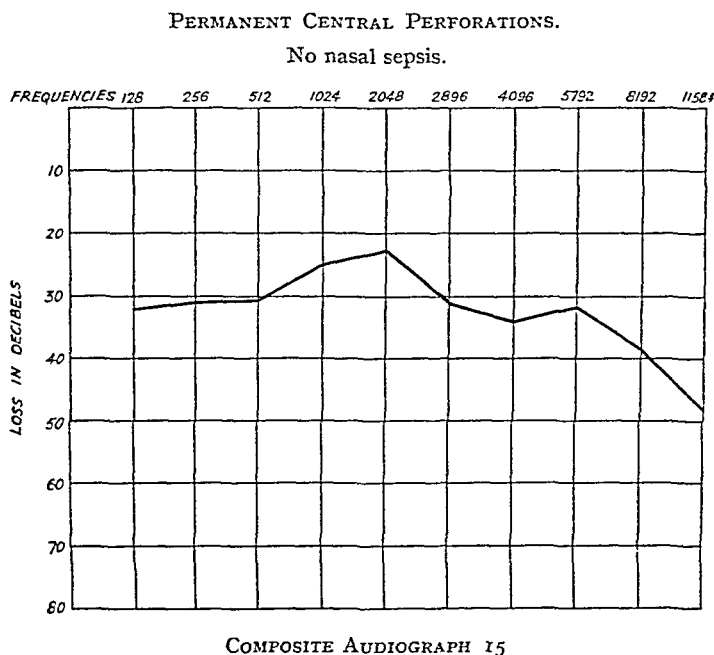
NH—80 decibels.

N. Asherson

9 cases in which there were no signs or symptoms of post-nasal sepsis, no less than 6 were dry.

Central Perforation : No Nasal Sepsis

The following shows the audiographs of 8 ears, 5 of which were dry, in which there was no evidence of nasopharyngeal sepsis.



Nasal Sepsis and the Composite Audiograph (16)

These were cases which were referred because of gross nasal disease, he re being no complaint of ear discharge or trouble.

There were 48 cases, with 96 ears in all. These were divided into two groups :

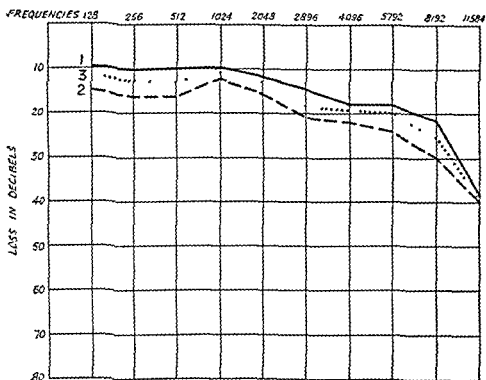
1. Those with apparently normal hearing (Cases 1-31, 62 ears).
2. Those with a low tone loss (Cases 32-48, 34 ears).

The curve 3 gives the average loss of hearing in 96 ears, with obvious nasal sepsis, the ears being apparently normal and no complaint being made of the hearing.

It is to be noted that the composite audiographs for the 96 ears show a low tone loss of 12 decibels, and up to 20 decibels for the higher frequencies. The highest frequencies are affected to a maximum extent.

The Radical Mastoid Operation

Composite Audiograph of 96 Ears (normal clinically) in Cases of Nasal Sepsis



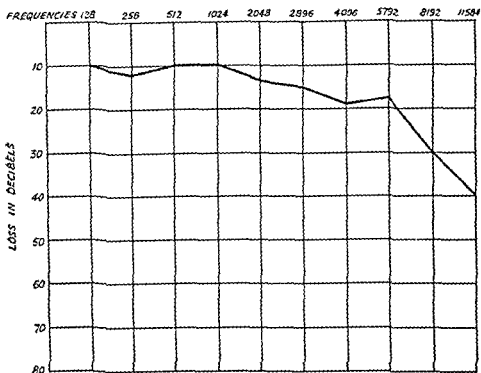
COMPOSITE AUDIOGRAPH 16

- 1 62 ears with minimal changes
- 2 34 ears with obvious eustachian catarrh
- 3 The composite audiograph of all these ears (96)

Otitis Externa

OTITIS EXTERNA

22 cases (44 ears)



COMPOSITE AUDIOGRAPH 17

N. Asherson

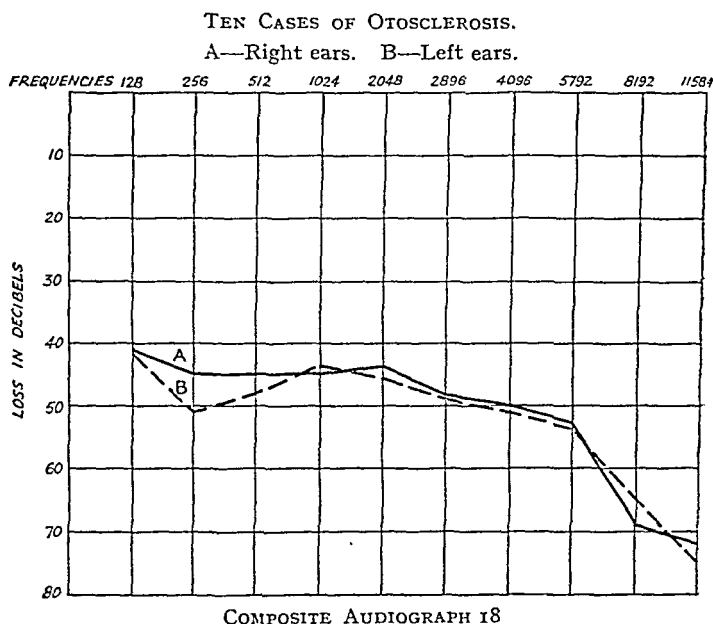
There were 28 cases with 56 ears out of 535 ears, just under 10 per cent. incidence. The condition is bilateral and the audiograph shows hearing almost within normal limits.

The high tone impairment is noticeable. It is due to secretions in the ear.

Otosclerosis

There were 10 cases of otosclerosis. All were of ages between 30 and 40; again this confirms the clinical observation that otosclerosis in men invariably manifests itself in the decade 30 to 40, whereas in women it is 20 to 30.

The ages of these cases were 31 (2), 35 (3), 36, 37 (2), 38 (2).



CLINICAL RECORD

RESPONSE OF OBSERVED OTITIC ENCEPHALITIS TO PENICILLIN AND CHEMOTHERAPY

By T. B. HUTTON (Leeds)

THE following case of otitic encephalitis is of clinical interest and thought to be worthy of record because the presence of the encephalitis was confirmed by direct observation of the brain substance on two occasions when exploration of the temporo-sphenoidal lobe was carried out for a suspected abscess. The encephalitis cleared up completely on treatment without the formation of a localized abscess, even though physical signs indicated a large area of brain substance was involved. Early treatment was possible because the first diagnostic symptoms and signs of the encephalitis appeared whilst the patient was in the ward under observation for a potentially dangerous ear. In my experience this is the first such case which has shown resolution of an extensive encephalitis without the formation of a brain abscess.

Case History

Margaret B., aged 14 years, was admitted to the ward for observation with a history of deafness and persistent discharge from the left ear for eleven years. Seven days previously there had been a transient attack of vomiting after the discharge had become offensive and suddenly decreased in amount with acute ear-ache for forty-eight hours. Her general health was good.

Examination revealed that the left external auditory meatus contained a little offensive pulsating pus. On cleaning, soft friable granulations were found to be obscuring the middle ear. X-rays confirmed a sclerotic mastoid process without a demonstrable cholesteatoma present. There were no signs of an intracranial complication. Local treatment to the diseased ear was then commenced but with little improvement, and a mastoid operation was considered necessary in the near future.

On the sixth morning after admission the patient was very loath to get out of bed, otherwise she felt well. The same evening a slight dull occipital headache had developed. There were no positive signs beyond the local condition of the ear.

The following morning the patient had become distinctly drowsy, although perfectly rational when roused. Early neck rigidity had now appeared, but otherwise there were no localizing signs. A diagnosis of early meningitis was made and lumbar puncture followed by exploration of the left mastoid was decided upon. The C.S.F. pressure was 300 mm., the film being normal and culture negative; estimation of protein was unfortunately omitted. The mastoid was approached through a post-auricular incision and found to be sclerotic. The large antrum exposed was packed with cholesteatoma and

offensive pus. The posterior bony meatal wall was eroded and a fistula found communicating with the middle cranial fossa and draining thin pulsating pus. The simple mastoid operation was then completed and "the bridge" thinned down in preparation for completion of the radical cavity at a later date. A large area of middle and posterior fossa dura with removal of the sino-dural angle was then exposed. The dura was not under tension but a small extradural abscess on the floor of the middle fossa with very early granulations was found and drained; a large area of lateral sinus was also exposed but found healthy. The wound was packed and the patient returned to the ward to start penicillin 100,000 units 3-hourly and sulphadiazine grm. 1 4-hourly. A film of the pus showed many Gram-positive cocci and the culture was a profuse growth of streptothrix, diphtheroids and coliform organisms.

During the next 24 hours the patient's condition deteriorated, contrary to expectations, and neurological signs appeared. At this stage the Neurosurgical Unit were asked to see the case. Drowsiness had increased with very marked aphasia and the patient was roused with difficulty. The pulse rate was falling with slight rise in temperature but no vomiting. The patient's co-operation was poor, but it was thought a right homonymous field defect had appeared and weakness of the right arm and leg was present with weakness of the left face. Sensation could not be tested with accuracy. There were no definite pyramidal signs and no papilloedema. The pupils were equal and both reacted to light. There were no cerebellar signs. Neck rigidity was still present. A diagnosis of left temporo-sphenoidal abscess was made and, in view of rapid deterioration, exploration was carried out through a clean left temporal incision by Mr. Henderson. A localized collection of thin pus under marked tension was found on incision of the dura and was situated over the left temporal lobe of the brain. This was evacuated and soft inflamed brain tissue observed; further exploration was not considered justifiable. The temporal wound was sutured without drainage and 15,000 units of intrathecal penicillin introduced by lumbar puncture. At this stage the C.S.F. protein was 260 mgr. per 100 c.c. and cell count 154, mainly polymorphs. The pus evacuated was later found sterile on culture.

The penicillin and sulphadiazine therapy was continued and in addition 15,000 units of intrathecal penicillin was introduced by lumbar puncture twice daily. Small specimens of C.S.F. taken each time showed a falling protein content and cell count.

On the seventh lumbar puncture the patient had an epileptiform fit starting in the right leg and spreading rapidly to the left leg and both arms, the trunk and face also being involved. The right arm remained by the side, whereas the left arm was extended above the shoulder with elbow flexed. The clonic stage lasted four minutes, to be followed by deep stupor and a right hemiplegia, the pupils remaining equal. Prior to this incident the patient's progress had been satisfactory. Since the general condition was now poor and a pressure cone suspected, Dr. Taverner's help was sought in the absence of Mr. Henderson. He found signs of a space-occupying lesion and decided to explore the left temporal lobe of the brain through the clean temporal wound already made. No localized pus was found, although a large area of brain tissue was observed to be soft, inflamed and discoloured. The mastoid wound was dressed immediately before

Clinical Record

the exploration and found healthy, with only slight increased tension of the dura

Sodium luminal was given to control the intensity of any further fits. Minor fits continued at about 2-hourly intervals for 48 hours after the exploration and then ceased. Transient retention of urine for 36 hours also presented but soon cleared up. From this time onwards the patient began to make an uninterrupted recovery. The mastoid was re-dressed on the twelfth day.

On the nineteenth day after the onset the encephalitis had resolved completely with no residual hemianopia or aphasia. The radical mastoid operation was then completed and the patient has remained fit ever since, a period of over three months. The C S F remains normal on analysis, cell count and culture, although there is a slight residual increase of pressure without symptoms or signs.

Discussion

In the treatment of this case the total doses used were penicillin 15,600,000 units by intramuscular injection and 105,000 units intrathecally, sulphadiazine 39 grm. It is considered that these large doses given early as an intensive course, together with surgery, were responsible for the early resolution of the encephalitis without formation of pus, even though the mastoid and extradural pus gave a mixed organism content on direct film and culture.

During treatment there appear to have been three divisions of the inflammatory reaction, namely (a) pus containing mixed organisms in the mastoid and extradural abscess, (b) sterile subdural pus overlying the left temporal lobe, (c) an extensive observed encephalitis of the left temporal lobe without formation of pus. There is no doubt surgical drainage was a major factor in the cure of the first two named collections of pus. The resolution of the encephalitis is more difficult to explain. During the discussion which followed the paper on the "Chemotherapy of Meningitis secondary to Infection of the Ear and Nasal Sinuses" given by Dr. Honor V. Smith at the Royal Society of Medicine on March 1st, 1946, Mr. F. W. Watkyn-Thomas said that "to control meningitis by any chemotherapeutic method, sulphonamide or penicillin, they must have an agent which would penetrate the perivascular sheath, pass along the vessels, and percolate the brain substance". In this case described it would appear that the complete resolution of the observed encephalitis could only have been achieved if the penicillin and sulphadiazine administered had exhibited the three criteria mentioned by Mr. Watkyn-Thomas. Also their action must have been rapid and prior to any disturbance of the blood-supply to the inflamed tissue to achieve resolution without formation of a cerebral abscess. At no time was penicillin given by the intraventricular route.

In recording this case I wish to express my gratitude to my chief, Mr. G. S. Seed, for his most helpful advice, and to Mr. Henderson and Dr. Taverner for their invaluable co-operation and exploration on the two occasions mentioned.

REFERENCE

- SMITH, SCHILLER and CAIRNS, March 1946. Discussion on the Chemotherapy of Meningitis Secondary to Infection of the Ear and Nasal Sinuses', *Proc. Roy Soc Med*, XLIV, No 10, 613

CLINICAL NOTE

THE POST-OPERATIVE TREATMENT OF THE RADICAL MASTOID OPERATION

By GILROY GLASS (Nottingham)

THERE have been many suggestions made regarding the ideal after-treatment of the radical mastoid cavity, and almost every surgeon has his own preference. The results by different surgeons probably vary little, and by every method the end result is probably in direct proportion to the meticulous after-care of the surgeon concerned.

Since the introduction of the "sulpha" group of drugs, their use has probably attracted the majority of surgeons, but their use has had two objections. In powder form they tend to cake, the resultant foreign body being irritating and difficult to remove; in solution it is doubtful whether the drug is sufficiently long in contact with the tissue to serve any useful purpose.

During the last two and a half years experiments have been made in the Nottingham General Hospital, to devise a simplified after-treatment utilizing the sulpha drugs, and one which is as free from discomfort to the patient as possible. After several experiments the following formula was devised:

R.	Sulphathiazole	Gr. xxii.
	Zinc Oxid.	3 ss.
	Lanette Wax (S.X.)	3 i grs. xx.
	Paraffin Molle Alb.	3 i grs. xx.
	Aqua ad	3 i.

When made up this ointment has a soft consistency, not unlike that of shaving cream, is water-soluble, and does not tend to cake or dry in any way.

At the operation the radical cavity is either packed gently with ribbon gauze soaked in liquid paraffin or flavine emulsion, or alternatively a soft rubber tube is placed in the meatus. In either case the first dressing is done on the fifth day and the packing or tube removed, and thereafter the case is treated with the sulphathiazole cream.

The method of use is to squirt the cream into the radical cavity with a 2 c.c. syringe, the nozzle of which is protected by a short rubber tube—bicycle valve tubing is ideal for the purpose. The tube effectively prevents damage or pain should the inner tympanic wall be touched. The following day the cream is washed out with 30 per cent. alcohol in saline, using a 10 c.c. syringe similarly protected with rubber tubing. A fresh 2 c.c. of sulphathiazole cream is inserted. The process is repeated daily till the cavity is dry.

Clinical Note

After two years' experience of the method it can be said

- i *The dressing is absolutely painless*
- ii The method does not require any great skill, and can be carried out by a nurse. Likewise no special equipment being required, it is a suitable method to be carried out by the patient's own doctor on his discharge from hospital, should he live at too great a distance for regular visits to the clinic
- iii The formation of excessive granulation tissue is inhibited, and therefore less frequent specialist supervision is required
- iv *Ultimate healing and epithelialization is quicker*
- v Up to date no case of skin sensitization to sulphathiazole has occurred

SOCIETIES' PROCEEDINGS

ROYAL SOCIETY OF MEDICINE—SECTION OF OTOTOLOGY

December 5th, 1947

President—DONALD WATSON, F.R.C.S.

Discussion on Penicillin Treatment in Acute Otitis Media*

MR. T. B. LAYTON said that the day was approaching when any case which passed from acute to chronic ear disease would be regarded as a criticism, not of a single individual, but of the general clinical administration of the medical profession. Mr. Simson Hall had asked what would happen to these patients in five years' time. It should be asked also what would happen to the nation in fifty years' time when Mr. Simson Hall's ideals had been put in action all over the country. Two things would disappear. One was hardness of hearing in the child during that part of education when the ear was the first and practically the only access to the brain from the educational point of view. The other was chronic ear disease amongst the middle-aged and elderly.

He was in profound disagreement with Mr. Simson Hall on one point. There was no evidence whatever that there was an increased pressure in the blind end of the middle-ear cleft when it was inflamed.

MR. E. G. COLLINS commented on the high tone loss, recovery from which was slower than in the low tone, and said that frequently this happened in the presence of lymphoid tissue. Had the openers any explanation of the relative slowness of recovery of the high tones? As far as penicillin resistance is concerned, Mr. Collins had, in the early days of penicillin, tried out local penicillin applications in the form of drops to cases of chronic otitis media. One case especially he remembered where a hæmolytic streptococcus had been cultured from an acute ear, and although this organism was sensitive to penicillin at the start of treatment, it became insensitive after a comparatively short time. He then stopped all treatment with penicillin and got the patient back in a month's time. The insensitivity to penicillin had now disappeared, and this suggested that this acquired insensitivity was probably due to inadequate dosage and the fact that the penicillin had been given by local application. In cases of chronic otitis media he thought that local penicillin treatment disturbs the bacteriological balance when there is a mixed infection present, and that the coliform organisms and the proteus assume far greater activity. He had found the same thing with penicillin lozenges. After their use, penicillin-resistant staphylococci could be cultured from the pharynx in far greater numbers than had been present before treatment, and there was also an increase in the coliform organisms. Mr. Collins suggested that a greater number of

* The opening paper appears on p. 551.

Royal Society of Medicine

intracranial complications due to Gram-negative organisms would now be found as the result of penicillin therapy

MR J H ORRY said that almost two years ago he started a somewhat similar line of investigation to that pursued by the authors, and he had records of a very similar series of cases in which a dry ear had been obtained and the patient discharged in an average period of $7\frac{1}{2}$ days. Of the 79 cases in his series, which were all cases of acute otitis media, there were seven in which a simple mastoid operation had to be done before a dry ear was obtained. The dosage of penicillin was 30,000 units, three-hourly by injection intramuscularly.

These cases, he thought, should all be treated in hospital. Twenty cases were treated on the old lines, without any sulphonamide or penicillin, to find out the duration of the discharge, and the average duration of discharge and stay in hospital was $12\frac{1}{2}$ days, a saving of five days in hospital, which was considerable.

On one point he was in disagreement with Mr Hall, namely, the suggestion that when penicillin could not be given efficiently the sulpha drugs should be used. From very early in the experience of these treatments he had been terrified of the masking effect of sulphonamides. At the beginning of the investigation a series of cases of acute otitis media were treated with large doses of sulphathiazole. These were adults, and from 30 to 35 grams of sulphathiazole were given over a period of five days. Of fifteen cases so treated, no fewer than nine had to have a simple mastoid operation before a dry ear was obtained, with return to normal function. He wondered whether in the adult a sufficient concentration of the sulphonamide was obtained in the mastoid. In children, perhaps, there was a better blood supply to the mastoid, and that might account for Mr Simson Hall's good results with the sulphonamides.

MR W A MILL said that fears had been expressed that the sulphonamides might cause masking. He confessed that he had not so far encountered this masking effect. When one was acting as one's own house surgeon in the Army and had cases under daily observation there were excellent opportunities for witnessing anything of the kind if it occurred. He had not found any masking. Therefore he was surprised on his return from service abroad to find it talked about so much and that house surgeons were afraid of it. Was it the experience of many members that masking was a real danger? If one kept in mind that the ear, after it had been inflamed, was not quite healthy until it was absolutely normal and so was on the watch during the whole period until normality returned, he did not think there was any real danger. Every sign must be noted, but so-called masking was a danger only when some sign or symptom had been overlooked.

MR L GRAHAM BROWN said that on the question of age incidence, he presumed that the majority of cases illustrated which had been dealt with over a period of years were in the lower age group—children and young adults—but perhaps there were included some of the older cases who were already suffering a certain amount of deterioration in higher tone frequency. He wished to learn what Mr Simson Hall could tell them on that matter.

Masking, he thought, was a real thing, but it did not occur so much now because they were all alive to the possibility. They knew that if they put cases on penicillin or sulphonamide they could expect something of this nature.

Societies' Proceedings

One's actual conduct of the case was rather formulated on those lines, that the use of these drugs in the earlier cases of acute inflammation of the middle ear should be in the very early stages indeed—in the first 24 hours—if one was to expect to avoid any complications. After that period the emphasis should be placed, not so much on the drugs, as on getting rid of the infection, whether by excision of the drum-head or the opening of the mastoid. It was better to continue in that way, especially having regard to the recent paper on the resistance of these organisms to the drugs.

MR. R. SCOTT STEVENSON asked about the value of Eustachian catheterization used at the end of treatment, and how far this had been employed in cases treated by penicillin and by sulphonamides respectively. He fully agreed with Mr. Simson Hall's emphasis on the fact that penicillin was an adjunct to, not a substitute for, surgery, and related a case in point.

MR. GAVIN YOUNG said that rather before the days of chemotherapy one was accustomed once or twice in a year to meet a case of latent acute mastoiditis. Now, as a result, he thought, of inadequate chemotherapy, such cases were encountered a number of times a year. On returning from the Scottish Otolological Society's meeting on the previous Saturday he found two of these cases of mastoiditis with intact drumhead and very little to show. Masking was a very real and definite thing, and he thanked the authors for bringing up the subject again, and for the way in which they had documented their cases.

MR. F. C. W. CAPPS said that it was necessary to bear in mind that although upper respiratory and aural infections might form a large part of present-day illness, they were by no means the whole of medicine, and that these drugs—penicillin and the sulphonamides—were being given in every other department of medicine in a very wholesale way. He thought that these cases must be treated with caution, that they must get back to fundamental principles, look at the clinical picture, and keep things on rational lines. Many general practitioners regarded these drugs as a panacea for all ills. He would like to have seen, for comparison with the series of cases presented by the authors, another series of cases treated on the old orthodox lines either by drainage or by an attempt to establish tubal drainage. He himself happened to be one of those who had suffered in childhood from acute otitis media. In the end the drum burst of its own accord. That was over 35 years ago, and the audiograms of his hearing were pretty good. It would be very useful to have the results in cases which had had neither of these drugs.

MR. W. A. MILL, intervening again in the discussion, said that the reason he had mentioned masking earlier was because he had found that there were fears expressed, not by otologists, but by some practitioners and house surgeons, that it might be dangerous to give sulphonamides or penicillin because of the risk of masking. He thought it would be very unwise if too much talk about masking went on in that Section. He was quite sure that none of them intended that these drugs should not be given, but that side of the question did not occur to some people; it should be made clear that there was no real danger of masking provided the case was looked after carefully.

MR. R. L. FLETT raised the question of the type of appearance of the tympanic membrane. If there was a yellow colour in the tympanic membrane, with pus, then he thought surgery was to be resorted to before the use of drugs.

Societies' Proceedings

very little value for the simple reason that epidemics varied so enormously, the types of organism concerned were different, as were the circumstances under which the epidemic took place. That was why some sulphonamide cases were included, to try to get a control. On one occasion he made an analysis of a series of 500 cases of consecutive occurrence of otitis media, and he found that the discharging ear treated in hospital cleared up on the average in 21 days, as against the 17 days which Dr. Young had quoted for the present series ; but the difference of four days was not significant, seeing that the circumstances were so greatly different.

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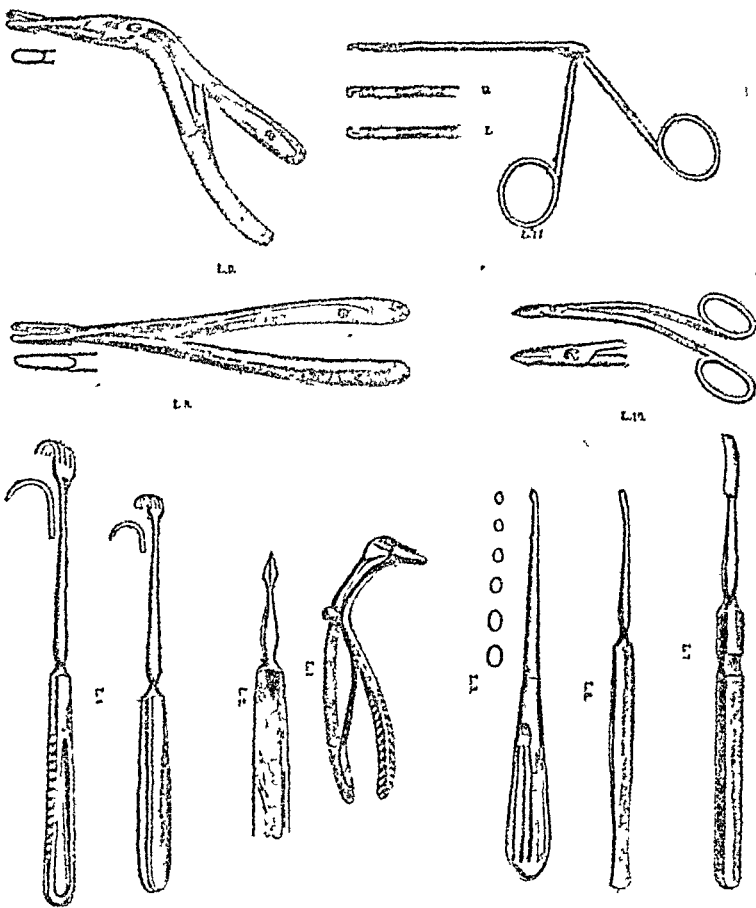
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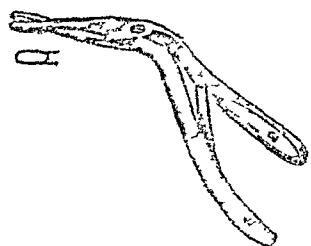
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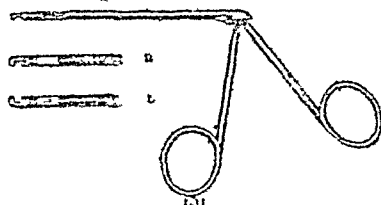
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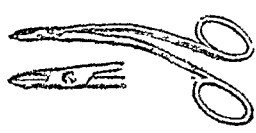
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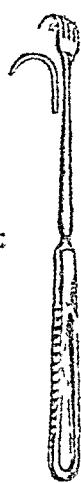
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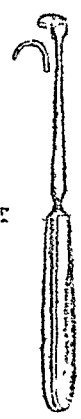
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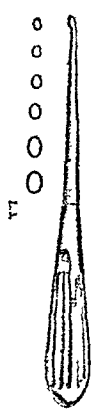
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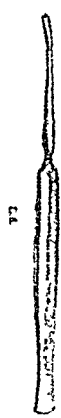
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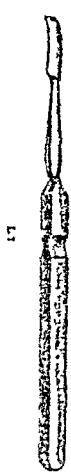
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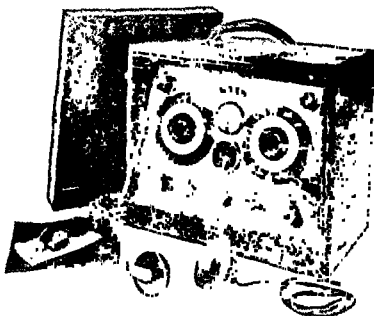
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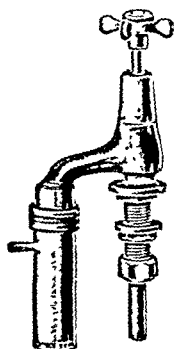
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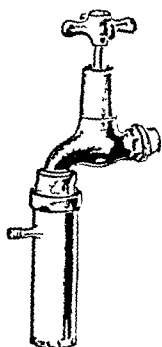
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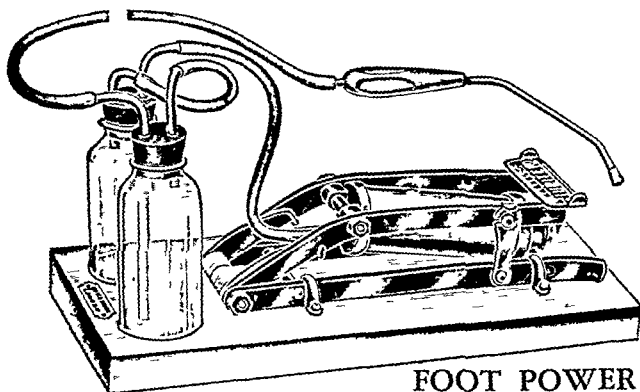


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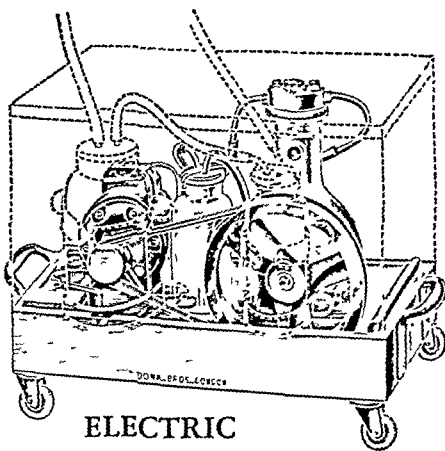
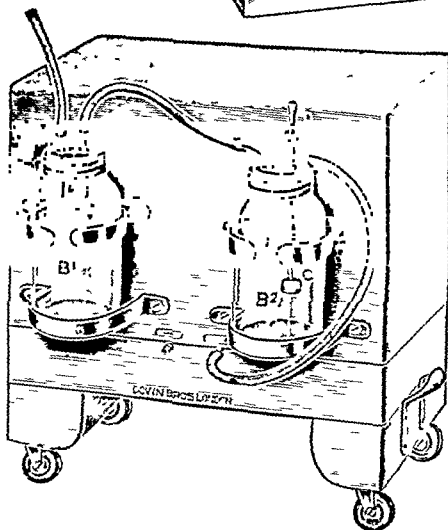


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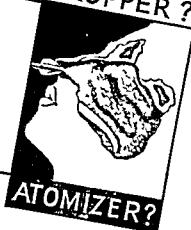
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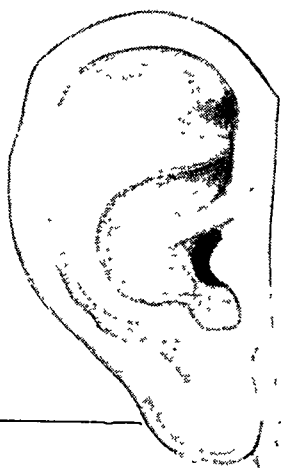
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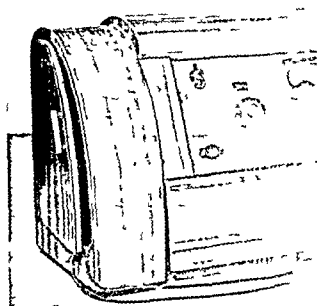
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October 1948

FURTHER OPERATIVE RESULTS OF CARCINOMA OF THE LARYNX

By Prof. Th. D. DEMETRIADES (Athens) and D. IOANNOVICH (Athens)*

In an earlier publication†, we recorded the operative results of carcinoma of larynx from six years' work in the clinic mentioned at the footnote and resolved to revert to the same subject when the passage of time permitted more definite results.

At that time, and also now, no other suitable Greek statistics on this subject have been available, so we are regretfully forced to confine ourselves to our own cases only.

The recent figures from our colleagues in this town, as well as from our own last operations have too short a follow-up of cases to be suitable for inclusion here at present.

The work under consideration comprises cases operated upon by us in the course of about sixteen years. These have been the subject of such deep investigation that the untraced cases have been classed under the cases of those who have died.

The results of our first series of cases (from 1931 to 1937) are tabulated below.

Type of Operation	Total No.	Deaths	Recurrences	Cures (3 years)
Laryngo-fissure (1924-1935)	4	—	—	4
Laryngo-fissure St. Clair Thomson Technique (1931-1933)	4	1	3	—
Malgaigne Hajek (1934-1939)	3	—	—	3
Total Laryngectomy (1931-1935)	21	5 23·8%	8 38·09%	8 38·09%
Total	32	6 18·75%	11 34·3%	15 46·8%
Percentage				

* From the Greek Red Cross Hospital, Athens.

† See references.

Th. D. Demetriades and D. Ioannovich

Of these 32 cases 18 were for the intrinsic and 14 for the extrinsic variety of carcinoma.

During the period 1931 to 1947 we had 74 operations for carcinoma of larynx (53 intrinsic and 21 extrinsic type). This number excludes an additional 10 cases of total ablation of larynx and 4 of laryngo-fissure whose results have not been included here owing to their being operated upon too recently (1947). These 14 patients enjoy perfect health.

The age incidence of these total 88 cases is as below :

Age group years	Number of cases	Percentage %
30/39	5	6
40/49	22	24
50/59	36	41
60/69	18	21
70/79	7	8

The sixth decade has the maximum incidence. Statistics from previous authors and other workers (e.g. W. E. Howes and M. Platau) also give very similar age incidence.

Sex. The ratio between males and females in carcinoma of larynx is approximately 10 : 1 (Hajek). In our own series we had only one female case out of a total of 88.

Topographical characters. The intrinsic variety of carcinoma of the larynx was very frequently found to be limited to the vocal chords and the extrinsic variety to the epiglottis.

Histological characters. Most of the intrinsic varieties showed differentiation of its cells with the presence of cell nests (epithelial pearls) whereas the majority of extrinsic carcinomata are undifferentiated. (See table below.)

Topographical Characters	Total	Differentiated Squamous Epithelioma	Undifferentiated Squamous Epithelioma
Intrinsic	53	34	19
Extrinsic	21	7	14

Types of Operations performed.

1. Total laryngectomy was performed in 35 cases (1931-1942). The lymph nodes lying along the carotid vessels were removed only in those cases where these were either palpable externally or the histological picture of the primary growth was that of all undifferentiated type.

2. Excision of the epiglottis. Performed in 4 cases.

3. *Laryngo-fissure.* For this operation we have always chosen those

Further Operative Results of Carcinoma of Larynx

cases in which the growth involved only the middle part of one vocal chord. The mobility of the affected vocal chord was uninterfered with and the growth did not extend below the rima glottidis. No lymph glands were palpable in the neck in addition (a) Laryngo-fissure with partial laryngectomy (Sir St.Clair Thomson Type). Four such operations were done during the years 1931-1933. (b) Laryngo-fissure with excision of the affected vocal chord was done in 31 cases during the period 1941-1946.

The details of the results of these operations are put down in the tables underneath.

INTRINSIC CARCINOMA 1931-1937

Type of Operation	Total	Deaths	Recurrence	Cures (3 years)
Laryngo-fissure (1924-1935)	4	—	—	4
Laryngo-fissure partial Laryngectomy. St. Clair Thomson (1931-1933)	4	1	3	—
Total Laryngectomy (1931-1936)	10	4 40%	1 10%	5 50%
Total	18	5 28%	4 22%	9 50%

EXTRINSIC CARCINOMA 1931-1937

Type of Operation	Total	Deaths	Recurrence	Cures (3 years)
Malgaigne Hajek (1934-1936)	3	—	—	3
Total Laryngectomy (1931-1936)	11	1	7	3
Total	14	1 7%	7 50%	6 43%

OPERATIVE RESULTS OF LARYNGO-FISSURE AND PARTIAL LARYNGECTOMIES

Type of Operation	Total	Post-operative Deaths	Recur- rences	Cures Total	% Cures
Laryngo-fissure Chordectomy (1929-1935)	4	1*	1	2	74
(1936-1946)	27	2	4	21	—
Partial Laryngectomy (1931-1933)	4	1	3	—	—
Malgaigne-Hajek (1934-1940)	3	—	—	3	100
1944	1	1	—	—	—
Total	39	4	9	26	↑
Percentage (%)		10	23	66	←

* Death due to spontaneous pneumothorax after 5 years.

Th. D. Demetriades and D. Ioannovich

Total Laryngectomy (1931-1942).

Of the 35 cases of total laryngectomy the results are :

Cured—6 cases or 17 per cent.

Analysis :

1 case	Recurrence free	for 17 years
2 cases	„ „	„ 16 „
1 case	„ „	„ 13 „
1 case	„ „	„ 8 „
1 case	„ „	„ 7 „

Out of these 2 were extrinsic and the remaining 4 intrinsic carcinomas. As has been mentioned before, the extrinsic types were undifferentiated histologically, whereas the intrinsic ones showed differentiation with presence of cell nests.

Post-Operative Mortality. 10 cases (26 per cent.) died during the post-operative period. Cause of death in these cases was post-operative complications as listed below.

Respiratory Complications

(Pneumonia and Bronchopneumonia)	..	7 cases
General infection .. .. .	..	1 case
Dysentery .. .. .	..	1 case
Circulatory failure .. .. .	..	1 case

Apparently the respiratory complications were the most frequent cause of deaths in the post-operative period.

In order to minimize mortality due to various causes the operation of total laryngectomy was carried out in two stages (Hajek). Stage I—tracheotomy and Stage II—laryngectomy, 15 days after.

Recurrence : Was observed in 13 cases (37 per cent.).

Analysis

3 cases after 2 months	1 Intrinsic, 2 Extrinsic.
2 cases „ 4 „	1 Intrinsic, 1 Extrinsic.
1 case „ 6 „	Extrinsic.
2 cases „ 8 „	Both Extrinsic types.
3 cases „ 1 year	2 Intrinsic, 1 Extrinsic.
1 case „ 16 months	Extrinsic.
1 case „ 14 years	Extrinsic.

Most of the recurrences took place 6-8 months after the operation and were mostly in cases of extrinsic carcinoma which histologically did not show differentiation of its cells.

Further Operative Results of Carcinoma of Larynx

It has been stated that cases of carcinoma of larynx which remain recurrence free for 5-7 years after operation may be regarded as cured. We wish here to point out that in our own series of cases we have two exceptions to this.

In one case an adeno-carcinoma appeared in the right tonsil fourteen years after the total laryngectomy for extrinsic, indifferntiated squamous carcinoma of larynx and in the other a squamous cell epithelioma was observed locally 21 years after laryngo-fissure for carcinoma of larynx.

We believe that perhaps both were of the nature of new tumours rather than recurrences of the original growths which were obviously removed successfully.

J. Terracol and C. Bringe also describe two cases in which metastatic growths were noticed eleven and seventeen years after operation.

Untraced Cases. In six of our series (17 per cent.) the subsequent whereabouts of the Patients in question could not be traced.

Conclusions. The percentage of individuals who enjoy recurrence free long life (7-17 years) after total laryngectomy (for carcinoma of larynx), is rather small (17 per cent.). The combined percentage of cures (5 years) for laryngo-fissures and laryngectomies is 43 per cent. For laryngo-fissure 21 among 27 patients are alive (74 per cent.) for more than 7 years.

These results, however, are from that period of time when we had no Chemotherapeutic or antibiotic drugs to control the post-operative infections, which alone have been responsible for deaths in about 26 per cent. cases after total laryngectomy.

All our cases except the laryngo-fissures were complementarily irradiated after the operation with the method of Coutard (5-7,000 r).

During the period when we had the sulpha drugs and penicillin we had no post-operative death in a series of 11 total laryngectomies and 4 laryngo-fissures.

The improvement in the results which follows the use of these drugs is therefore very striking. Not only is the danger of post-operative infection almost eliminated but the healing of the operation's wound is hastened thereby enabling us to remove the œsophageal tube in 6-8 days and start the complementary X-rays treatment 15 days after operation. Previously we had to wait for nearly 60 days before we could send the patient to the radiologist for deep X-rays.

Time is the most important factor in the treatment of malignant disease and we here once more emphasize the fact that the treatment of carcinoma of larynx like any other carcinoma is a matter of early diagnosis (preferably by repeated biopsies, which allows us to know the histological characters) and operation. In our opinion the non-operative methods of treatment (X-rays and radium) have no place in the treatment

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of carcinoma of larynx unless used in conjunction with operation in operable cases and as a palliative in non-operable cases or recurrences. We know that other authors (f. i. Cutler) are recently of different opinion, advising irradiation for cases of intrinsic carcinoma, too extended for laryngo-fissure but without fixation of the cord.

We have also read the very interesting publication of Coutard about 142 patients having either inoperable carcinoma of the larynx or recurrences treated with röntgen rays, with 19 per cent. survivals after 15 years and 22 per cent. for 10 years. These good results are very encouraging. But for us who got our laryngological education in the surgical period of the treatment of carcinoma of larynx, and also have known the very poor results of röntgen ray treatment of larynx carcinoma, of the last 20 years the responsibility will still forbid us to advise irradiation in operable cases.

Certain cases come under observation when they show a hyperkeratosis. Such cases should be investigated very carefully and a keen lookout be maintained, for any precancerous change: treatment if carried out should give very satisfactory results.

Some authors have described removal of small early carcinomata of larynx with diathermy by the oral route. We, however, prefer to do laryngo-fissure in such cases as this procedure gives an opportunity to the surgeon to inspect more thoroughly the inside of the larynx and deal with the growth more effectively, at the same time leaving behind a good functional voice.

Below is a table showing comparative statistics from various authors.

STATISTICS FROM VARIOUS AUTHORS

Name of Operator	Number of Laryngectomies	Cures in Years			
		1-3	1-5	1-10	1-15
Howes Platau (1945)	5		3 60%		
McCart (1946)	21	21 100%			
MacKenty (1929)		73.5%			
New and Waugh (1934)			56.1%		
Jackson (1947)		50-60%			
Portmann and Mousset (1946) ..			50%		
Le Jeune (1947)		48.7%	38.4%		
Th. Demetriades and D. Ioannovich	35		38.9%		17%
Hajek-Heindl	256	23.43%			
Gluck-Soerensen	470	30%			
Von Lenart	56	28.57%			
New G.B. Mayo Clinic (1946)* ..	213		60.2		

* *Excerpta Medica*, O-R-L., Vol. 1.

Further Operative Results of Carcinoma of Larynx

Some authors have in their figures given survival rate instead of the duration of cures (recurrence free) the latter must necessarily be lower since most of the patients who have recurrence live for many months or even years after the same is noticed.

Summary

The results of operative treatment of carcinoma of larynx have been discussed.

In the period before the advent of sulphonamides and penicillin the post-operative mortality has been rather high (20 per cent.) and the percentage of complete cures rather low (17 per cent.). The use of these drugs is expected to improve these results considerably.

The value of early diagnosis and proper surgical treatment in the treatment of malignant disease of the larynx has been stressed.

The sixth decade of life has been found to have the highest incidence of carcinoma of the larynx.

This disease is much more common in the male than in the female sex.

We think that it is too early to decide a change of the classic rules of treatment of the cancer of the larynx in order to prefer irradiation until more statistics of more than 10 years survival are known.

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THE TREATMENT OF LARYNGEAL PAPILLOMATA IN CHILDHOOD

By H. ZALIN (Liverpool)

PAPILLOMATOSIS of the larynx occurs in infancy and childhood. It is somewhat uncommon. Estimates of incidence vary from 1 in 1,000 patients under 14 at the Massachusetts General Hospital¹ to 1 in 6,000 patients at the Children's Hospital in Boston². It is said to be more frequent in males, has its maximum incidence between 18 months and 4 years and is not familial, although 20 per cent. of all cases are congenital³. There is evidence that a filterable virus is the causative factor⁴.

Adult and infantile types of papilloma seem similar histologically, but behave differently. In adults single papillomata occur, usually on the vocal cords. Complete removal is occasionally followed by recurrence and in this event malignant change is a likely possibility. In children papillomata are multiple, and in addition to being found on the vocal cords, ventricular bands and aryepiglottic folds, are frequently present in the subglottic zone, trachea, bronchi, epiglottis, tongue and oral mucous membrane. They may proliferate around a tracheotomy opening. Removal is followed by rapid recurrence but there is no tendency to malignant change. In the absence of complications, with survival to puberty a dramatic recession occurs. There is sudden cessation of growth, spread, implantation and recurrence after removal. In some cases quiescence antedates puberty. In a recent series of 15 cases the disease burnt itself out spontaneously after an average period of three years from the date of diagnosis⁵.

Presenting symptoms are hoarseness and laryngeal dyspnoea. Either may predominate and vary in degree to complete aphonia, stridor, cyanosis and recession.

Treatment is anxious and tedious. There is a high mortality from respiratory complications. Death is due to asphyxia or pneumonia. Modern methods have improved the position from a fatal outlook for the majority of cases⁶ to a 20 per cent. mortality in a recent series of 15 cases⁷. Crowe and Breitstein hold that the mortality in children under 5 equals and possibly exceeds that of carcinoma of the larynx in adults.

Appropriate treatment should aim at

- 1 Relief of urgent symptoms, in particular asphyxia
- 2 Clearance of the laryngeal thoroughfare as adequately and frequently as necessary

3. Avoidance of local injury and its sequelæ—dysphonia from cordal damage, laryngeal stenosis from soft tissue scarring or perichondritis. New and Erich list the following :

1. Tracheotomy alone.
2. Avulsion of the tumours with a forceps, knife, curette, snare or punch.
3. Cauterization.
4. Fulguration or Electro-coagulation.
5. Application of radium.
6. X-ray irradiation.
7. Thyrotomy.
8. Destruction with Escharotics.
9. Medication—in particular Calcined Magnesia⁸.
10. Combinations of the above.

They express a preference for diathermy with the +ve electrode using suspension laryngoscopy and treating the papillomas as they re-develop. They feel that those who advocate radium have not observed their cases long enough to discover its disadvantages.

Chevalier Jackson⁹ advises avulsion. "These growths constitute a benign self-limited disease and all radical removal of basal tissues is absolutely contra-indicated. Destruction by radium or the X-ray is usually attended by perichondritis, stenosis and a disastrous destruction of the larynx that would be justifiable for cancer, but for the self-limited papillomata of children, it is a calamity. The growths repullulate on the surface and do not infiltrate the basal tissues. Experience in hundreds of these cases at the Bronchoscope Clinic has taught us that superficial removal repeated as frequently as necessary ultimately results in a cure with a good voice and perfect restoration of the airway."

Irradiation is condemned by most authorities, including Lemaitre¹⁰, Clay¹¹ and Colledge¹², as being fraught with grave danger to the delicate growing laryngeal cartilages.

Tracheotomy alone was used when endolaryngeal surgery was in its infancy. The airway was maintained by tracheotomy until, with the advent of puberty it was hoped the papillomata would have receded sufficiently for normal respiration to be resumed. The complications of prolonged tracheotomy are hypoplasia of the larynx, subglottic stenosis, tracheal sloughing, tracheo-oesophageal fistula and mediastinitis. Tracheotomy for the relief of urgent dyspnoea and as a first stage in the treatment is necessary in most cases. Its omission constitutes a gamble and the odds in each case must be carefully calculated, regard being paid to the fact that the risk is finally sustained by the patient. As a definitive procedure under local anæsthesia it has no mortality and enables a general anæsthesia to be administered subsequently, with ease and control, for endolaryngeal inspection and clearance. Avoidance of

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tracheotomy renders anæsthesia a major hazard and the necessity for emergency tracheotomy with all its dangers becomes highly probable. In the face of dyspnoea all are agreed on tracheotomy¹². In a series of 15 cases, however, Ferguson and Scott² were able to avoid tracheotomy in 6 patients, but a policy of dispensing with all anæsthesia in the presence of the slightest respiratory obstruction was adopted. This implies an exceptional degree of skill. All three of my cases required tracheotomy and out of a total of 5 cases Broyles¹³ performed tracheotomy in 4. Decannulation is indicated as soon as a clear airway has been obtained through the glottis and is preceded by progressively obstructing the cannula over a period, with observation of response. Further endolaryngeal therapy is then comparatively safe and may sometimes be performed without anæsthesia.

The wide range of therapeutic measures advocated suggests dissatisfaction with the results. In the hands of New and Chevalier Jackson, local removal, repeated in some cases at monthly interval for years, may well be followed by retention of perfect function. In other hands there must be danger to phonation and laryngeal patency.

Recently an attempt has been made to prevent recurrence following removal by the local application, through direct laryngoscopy or spray, of œstrogen^{13, 14}. In a series of 5 cases aged between 5 and 8 of which 4 required tracheotomy 0.1 c.c. of 10,000 units œstrogen per c.c. of oil were applied weekly at the Johns Hopkins Hospital^{13, 14}. The number of applications varied from 5 to 11 and local removal was performed as required. All the cases cleared up in around 6 months.

The line of thought which suggested this treatment is fascinating. Tehinde and Brawner¹⁵ demonstrated the effect of local œstrogenic hormones on the vaginal mucosa of young girls. They were concerned with the problem of gonococcal vaginitis in children, then a resistant and intractable infection requiring on the average four months of routine therapy for cure, with a considerable tendency to relapse. The adult vagina on the other hand, is highly resistant to gonococcal infection. At puberty vaginal epithelium undergoes a change to the adult type and gonococcal vaginitis existing at this time will be observed to subside. In the prepubescent vagina the mucosa is thin and delicate being composed of immature squamous epithelium 6-14 layers deep. The mucosa of the adult vagina is stratified squamous epithelium 25-40 layers deep.

In 17 cases gelatin suppositories containing 75 units of amniotin were inserted daily into the vagina. All cases were cured after an average period of 26.3 days. Biopsy of vaginal mucosa at intervals during treatment showed a change of vaginal epithelium to the adult type which persisted for 4 weeks after termination of treatment and then reverted to its original state.

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It is rather a firmly established fact that a serous labyrinthitis may eventually be a reversible disease. Some otologists like Alexander even claim that a serous labyrinthitis, in contrast to a purulent labyrinthitis, is invariably a reversible disease. This categorical point of view is useful from the clinical point of view, but it is not confirmed by pathological findings. For unknown reasons, serous labyrinthitis does cause eventually irreversible changes in the labyrinth and among these, an irreversible hydrolabyrinth. Herzog has emphasized that very virulent, particularly purulent infections never cause a hydrolabyrinth. Only these instances of serous labyrinthitis are supposed to result in a hydrolabyrinth in which the infection is of low virulence and is active for a long period of time as for instance the tuberculous otitis. It seems that the opinion of Herzog is correct.

If there is an abnormal amount of serous or serofibrinous fluid in the endolymphatic inner ear, the endolymphatic pressure increases, the membranous walls, particularly these which are not endowed with sensorial epithelium and nerves, become distended and eventually the sensorial epithelium is damaged. Since serous labyrinthitis is never a localized disease, the entire inner ear is involved. In other words, the increased endolymphatic pressure must be effective upon all walls of the internal ear. But the distension involves particularly and primarily the pars inferior, viz., cochlea and saccule, for various reasons: (a) the endolymph is chiefly produced in the cochlea; (b) in the cochlea and saccule there are thin walls, not endowed with sensorial epithelium and nerves, which may bulge far into large perilymphatic spaces, if the endolymphatic pressure rises; (c) there is no perilymphatic tissue in the cochlea and saccule, interfering with the distension of the membranous walls. For this reason, there is primarily a reversible or irreversible distension of Reissner's membrane and of the free wall of the saccule, if the endolymphatic pressure rises. The influence of the accumulations of fluid upon the sensorial organs was ably analysed by Herzog and Zange who emphasize that Corti's organ and its nerves are more extensively and more rapidly damaged than the maculae and cristae.

The most significant feature, however, is the distension of Reissner's membrane. The distended Reissner's membrane may be mobile or may be fixed in an abnormal position. The fixation may be caused by newly formed connective tissue which originates from the organization of the serous exudate, or by serofibrinous exudate. In the microscopic specimen the distended Reissner's membrane will be seen, therefore, in various position when the endolymphatic pressure has ceased. In extreme cases the enormously distended membrane is fixed toward the walls of the scala vestibuli, causing an enormous dilatation (ectasia) of the cochlear duct. In the vestibulum the increased pressure may even cause a rupture of the membranous walls. In less extreme cases a part

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of Reissner's membrane is fixed above the stria vascularis, the rest of the membrane is mobile. This is called "the high insertion of Reissner's membrane". In other cases, the entire membrane is mobile and wavy. Or, the distended membrane may sag toward the basilar membrane of the cochlea and may become fixed by fibrinous exudate to Corti's membrane, Corti's organ, external spiral sulcus and vascular stria, causing a considerable narrowing of the cochlear duct. This is called "collapse of Reissner's membrane".

The distension of Reissner's membrane is frequently associated with a similar distension of the free wall of the saccule and eventually with a marked degeneration of Corti's organ and spiral nerves. These findings constitute the hydrolabyrinth, which is a partial hydrolabyrinth because it involves cochlea and saccule but not the other parts of the internal ear. In more advanced cases the utricle and eventually one or more semicircular canals become likewise dilated. These findings constitute the complete hydrolabyrinth. The ampullae of the semicircular canals almost never become dilated (Alexander²³).

It is the merit of Hallpike and Cairns to have stated that a hydrolabyrinth, partial or complete, represents the pathology of Ménière's disease. Regarding the pathogenesis of the hydrolabyrinth, they believe in the absence of an infection of the tympanic cavity or the meninges or the blood "that the endolymphatic dilatation in these cases is due, at any rate in part, to some failure in the normal absorptive mechanism". The cause of this failure is supposed to be a fibrosis of the loose vascular tissue surrounding the endolymphatic duct. This concept is not tenable because this type of fibrosis may be found without hydrolabyrinth as emphasized by Hallpike and Cairns and because there is experimental evidence indicating that the normal endolymph is probably not absorbed in the endolymphatic sac (Lindsay²⁴). Hallpike and Cairns apparently feel likewise not sure about their own concept, because they continue by saying that "the primary change may still be either an increased production of the endolymph itself, or else some inscrutable type of alteration in its physico-chemical constitution".

Obviously the problem what causes the hydrolabyrinth in Ménière's disease is not solved. It is likely that the following cases may answer this question, at least for these individual cases.

CASE I.

K.B., white female, age 68. The patient had no serious illnesses. About two weeks ago she suddenly became ill with severe attacks of whirling dizziness, vomiting, tinnitus and an abrupt diminution of hearing on both sides. The diagnosis of "Ménière's disease" was made, but a thorough examination of the ears was not performed. However, a spinal puncture was made which revealed a positive Wassermann reaction in the spinal fluid. Two weeks later she became delirious and expired after four days.

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Autopsy revealed an osteitis deformans of the skull, arteriosclerosis of the cerebral blood vessels, sclerosis of the coronary arteries, mesaortitis luetica, aneurysm of the aorta and an arteriosclerosis of the kidneys.

Microscopic examination of the temporal bones.

The changes are on both sides essentially the same.

All spaces of the cochlea are filled with a sero-fibrinous fluid which stains with eosine and contains a few lymphocyte-like cells, adherent to the walls of the osseous inner ear (Fig. 1). The fluid enters likewise the channels of the modiolus and the meshes of the spiral ligament. In the specimen the exudate within the endolymphatic spaces has a granular appearance; in the perilymphatic spaces the fluid stains darker with eosin and contains fibrin. Corti's organ shows post-mortem changes; in the vestibular portion of the cochlea (Fig. 2) it consists only of one layer of flat cells. In the other coils the pillar cells can be clearly distinguished and, when the amount of exudate is small, the internal sensorial cell can be likewise recognized. Stria vascularis consist of a loose connective tissue, harbouring exudate, and contains large capillaries. In the vestibular portion Reissner's membrane is bulged toward the basilar membrane and adherent to the stria. Corti's membrane is in normal position. In the lower part of the basilar coil Reissner's membrane is adherent to the stria and the cochlear duct is very narrow. Corti's membrane is adherent to Corti's organ. In the upper portion of the basilar coil and in the middle coil Reissner's membrane is bulged toward the basilar membrane, but not adherent to the stria. Corti's membrane is adherent to Corti's organ. In the tip of the cochlea Reissner's membrane is slightly bulged toward the scala vestibuli; Corti's membrane is oedematous and raised from Corti's organ. The nerves and ganglia cells of the cochlea are extremely small in number. In the vestibular portion ganglia cells are entirely absent. The cochlear nerve is markedly atrophic. The vestibular ganglion is apparently normal.

In the perilymphatic cisterna the fibrinous exudate forms a wall which has the same localization as the vestibulo-cochlear septum of Alexander (Fig. 2). Utricle and saccule and ductus reuniens are filled with a granular exudate; their walls are covered from without by a layer of homogeneous exudate. Macula utriculi shows post-mortem changes; it is normal. The utricular nerve seems to be slightly atrophic. The semicircular canals are partially filled with granular exudate. Cristae are normal. The endolymphatic duct is dilated, contains granular exudate: its epithelium covers an oedematous connective tissue, poor in nuclei.

The temporal bones show an osteitis deformans. Tube, tympanic cavity and antrum are normal. The drums do not show the normal tension; malleus and incus are osteoporotic. Stapes and windows are normal and so is the pneumatization.

In this case the diagnosis of Ménière's disease was made by a physician about 14 days prior to the death of the patient. According to the description, given by the patient, it was a grand attack, consisting of labyrinthine and cochlear symptoms. At autopsy the labyrinths were filled with a fluid which was neither pus nor peri- or endolymph, which

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had rather the appearance of serofibrinous exudate, containing a few lymphocyte-like cells

The question which has to be answered concerns the origin of the fluid in the presented case. At present, this question can be answered more in the negative than in the positive. The fluid is not produced by a hypersecretion of the stria because the fluid contains fibrin and cells. For this reason the microscopic findings cannot be classified as a hydro-labyrinth. However, the term 'serous labyrinthitis' is likewise not quite correct because there is no infection of the tympanic cavity, of the meninges or of the blood stream which could have caused an inflammation of the labyrinth. The positive Wassermann reaction in the spinal fluid is likewise not responsible because a serous labyrinthitis in a case of late tertiary syphilis which is not associated with a syphilitic infection of the temporal bone, would be extremely unusual. I have believed that in this particular case the accumulation of fluid may have been caused by the osteitis deformans. The transformation of bone may have released metabolites which exerted a toxic effect upon the labyrinth. This concept may be plausible, however, there are several objections. In Paget's disease the transformation of bone frequently extends to the endosteum of the internal ear. Nevertheless, the finding of accumulation of fluid in the internal ear is an exceptional finding. In addition, hydro-labyrinth in Ménière's disease was frequently discovered in cases, not afflicted with Paget's disease. For this reason, Paget's disease cannot be the only cause of the serous labyrinthitis. At present, it is not possible to determine the other factor which rendered the blood vessels of the labyrinth permeable in the presented case. Obviously the concept of an allergic or hormonal influence upon the blood vessels immediately turns up. However, there is no definite proof in this respect. For this reason, I have used the preliminary term 'otitis interna vasomotoria' (vasomotor labyrinthitis) to designate the accumulation of serofibrinous fluid in the internal ear in instances which have no infection in the tympanic cavity or in the meninges or in the blood stream (Brunner²³). Since the arteries of the internal ear are branches of cerebral arteries the presented concept may explain also the headache which frequently is associated with Ménière's attacks and which even may replace the dizzy spells. Encephalographic studies, however, performed immediately after the attack failed to show pathology in the posterior cranial fossa.

The last question which has to be answered is the relationship between vasomotor labyrinthitis and hydro-labyrinth. The following case is supposed to answer this question.

CASE II

P J, white male age 58. In 1912 following an influenza the patient became suddenly hard of hearing. Ever since he suffers from attacks of dizziness.

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and headache. For a certain period of time there was vomiting. He also suffered from gallstones and general œdema. He frequently loses the balance in walking and gives the impression of being drunk.

On July 9th, 1921, there was an œdema of the lids, of the legs, of the scrotum and of the sacrum. The patient is very deaf and a communication is only possible by writing. The drums are retracted. There is a pastpointing to the left in the right arm. There is no adiadochokinesis, but the gait is unbalanced. There is no Babinsky. The labyrinths are excitable, perhaps hyperexcitable to the caloric stimulation. The patient complains of being dizzy. On July 23rd, the dizziness has decreased. On July 29th, the patient is stone deaf on the left side, on the right side he understands words, shouted into the ear. He does not hear high tones or low tones by air conduction. The a²-fork is heard by bone conduction on the left side for 3 to 4 seconds, on the right side for about 10 seconds. There is no spontaneous nystagmus. There is a hypo-excitability of high degree of both labyrinths which is on the left side more marked than on the right. Practically there is non-irritability on both sides. Examination on the turning chair was not performed. On October 14th, the patient expired.

At autopsy an arteriosclerosis of the coronary arteries, a fibrous myocarditis, a pneumonia, a chronic hydrocephalus and an osteitis deformans were discovered.

Microscopic examination of temporal bones.

On the left side the cochlear duct is very much dilated, particularly at the base and at the tip of the cochlea (Fig. 3). In the vestibular portion of the cochlea Reissner's membrane is separated from the bony wall of the scala vestibuli only by a narrow slit. At the tip Reissner's membrane is not only adjacent to the walls of the scala vestibuli, but bulges through the helicotrema into the scala tympani. In the superior portion of the basilar coil and in the middle coil approximately two-thirds of the scala vestibuli are occupied by the cochlear duct. In the inferior portion of the basilar coil the dilatation is less marked, but Reissner's membrane forms pouches which extend into the scala vestibuli of both the middle coil and the vestibular portion of the cochlea. The entire Reissner's membrane of the basilar portion has a wavy appearance and the pouches are simply excessive outgrowths of Reissner's membrane.

In Corti's organ the sensorial cells are absent; the supporting cells are fairly preserved. Corti's membrane is in normal position. Only in the vestibular portion Corti's membrane is reflected toward the surface of the crista spiralis and ensheathed by connective tissue. Ligamentum spirale consists of a loose connective tissue, which only on some places has a more dense texture. Stria vascularis shows post-mortem changes. The spiral nerves and the spiral ganglia show a considerable loss of nervous elements which is particularly marked at the base of the cochlea. In the walls of the channels of the modiolus there is a formation of osteoid tissue. The cochlear nerve in the internal meatus is atrophic. The sacculus is dilated, the ductus reuniens is normal. The utricle is enlarged toward the windows. The lateral wall of the utricle forms a small pouch which is connected by connective tissue with the oval window. The cisterna perilymphatica is reduced to a small space between utricle and sacculus. The macula sacculi consists only of a small

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amount of epithelial cells. Sensorial cells and otoliths are absent. The macula utriculi shows marked post-mortem changes, seems to be smaller than under normal conditions. Otoliths are absent. Utricular nerve is slightly atrophic. The endolymphatic duct is slightly dilated, it is surrounded by firm connective tissue. Cochlear aqueduct is closed by connective tissue and contains corpora arenacea. The cristae show post-mortem changes. Cupulae are absent. Semicircular canals are normal.

There is no infection or remnants of infection in the tympanic cavity. On the right side the tympanic cavity is likewise normal.

The cochlear nerve shows a moderate atrophy. The vestibular ganglion is perhaps less rich in ganglia cells as under normal conditions. The facial is normal. In the cochlea there is a moderate atrophy of spiral ganglia and spiral nerves which is marked only in the basilar and vestibular portion. Corti's organ shows post-mortem changes, but the supporting cells are apparently normal. Stria vascularis shows a loosening of the cells, the spiral ligament consists of a loose network of connective tissue. The meshes of the network are large, almost cyst-like. Reissner's membrane is in normal position and there is a small amount of granular exudate in the scalae of the basilar portion. The arterioles in the internal meatus, in the modiolus and in the laminae cribrosae show a thickening of the adventitia and small strips of calcium within the adventitia. The cochlear aqueduct shows the same changes like on the left side.

The ductus reuniens is slightly enlarged and so is the saccule at its junction with the ductus reuniens. At this side the wall of the saccule is wavy (Fig 4). The macula sacculi shows post mortem changes. The nerve is slightly atrophic. In the macula utriculi there are only a few sensorial cells. There are no otoliths. The utricular nerve is moderately atrophic. The inferior recess of the utricle is slightly dilated and shows a small pouch at its lateral wall. In addition, there is a crista quarta in the lateral wall and an atypical epithelial spot in the mesial wall of the inferior recess of the utricle. The epithelium of the crista quarta contains small cysts. There is a slight dilatation of the endolymphatic duct at its junction with the saccule. Otherwise the endolymphatic duct is normal and is, like the endolymphatic sac, surrounded by firm connective tissue.

There is a serofibrinous exudate in the vestibulum (Fig 4). The exudate fills the scalae of the vestibular portion of the cochlea, the perilymphatic cisterna and the saccule. In the specimen it has a granular appearance, in the lumen of the saccule it forms a fine network (Fig 4). There is no exudate in the utricle, in the ductus reuniens and endolymphatic duct.

The cristae show post mortem changes, their nerves are normal except in the inferior crista the nerve of which is slightly atrophic. There is a small amount of serous exudate in the frontal and horizontal ampullae.

The footplate of the stapes is slightly bent toward the vestibulum, but the anterior portion of the stapes is slightly displaced toward the tympanic cavity. The endosteum of the footplate is oedematous. The membrane of the round window is wavy.

Hans Brunner

is similar to the relationship between otosclerosis and stapes ankylosis. There is otosclerosis without stapes ankylosis and there is Ménière's disease without hydrolabyrinth. But, on the other hand, stapes ankylosis is most frequently caused by otosclerosis and likewise hydrolabyrinth is frequently caused by Ménière's disease.

More important for the pathogenesis of Ménière's attacks than hydrolabyrinth is the vasomotor labyrinthitis. This finding was obtained only in the presented cases. Consequently the following discussion is based on the findings in the presented cases, although Hallpike and Cairns have likewise noticed albuminous coagula in the inner ear of their cases. However, they refer this finding to the operation on the vestibular nerve which was performed a short time prior to the death. The presented cases prove that the albuminous coagula may be found although no operation has been performed. The finding of newly-formed connective tissue in the perilymphatic spaces of the cases of Hellmann, Hallpike and Cairns and others is an additional indication that vasomotor labyrinthitis does occur in cases of Ménière's disease.

From this discussion the following concept would emerge: Ménière's attack is caused by a vasomotor labyrinthitis which may resolve without leaving any traces or which eventually may cause a hydrolabyrinth associated with a degeneration of sensorial organs. This implies that vasomotor labyrinthitis causes essentially the same symptoms as does, for instance, an acute serous labyrinthitis due to an acute otitis media, viz., an acute attack of dizziness, nystagmus and deafness. This concept simplifies considerably the problem of Ménière's attack, but unfortunately in this case simplicity is not a test of accuracy. I³⁰ have noticed a vasomotor labyrinthitis in a case of osteitis deformans of the temporal bone who suffered from a profound deafness, but never complained of dizzy spells; and I³¹ have noticed likewise a vasomotor labyrinthitis after experimental head injuries in animals which did not show labyrinthine symptoms. From these facts the following conclusion must be drawn: Granted that my findings in Ménière's disease should be confirmed by others, it is likely that there is invariably a vasomotor labyrinthitis or the result of it, viz., a hydrolabyrinth, if there is a Ménière's attack. But this statement should not be reversed. The finding of a vasomotor labyrinthitis or hydrolabyrinth respectively does not necessarily indicate that there has been a Ménière's attack. A vasomotor labyrinthitis may cause deafness and tinnitus, but may fail to cause dizziness and nystagmus. In this respect vasomotor labyrinthitis is not unique, it is rather analogous to the acute serous labyrinthitis of bacterial origin, because in a serous labyrinthitis due to a tuberculous or scarlatinous otitis media or due to a meningitis, the labyrinthine symptoms are likewise frequently absent or inconspicuous, the principal symptom being deafness, complete or incomplete, transitory



FIG. 1

Section through the cochlea on the left side. Note the atrophy of the spiral ganglion, the exudate in the endo- and perilymphatic spaces and the slight dilatation of the cochlear canal in the tip coil.



FIG. 2

Section through the utricule, interior ampulla, perilymphatic cisterna and vestibular portion of cochlea on the right side. Note the sero-fibrinous exudate in all cavities of the internal ear. In x the exudate forms a vestibulo-cochlear septum.



FIG 3
Hydrolabyrinth on the left side

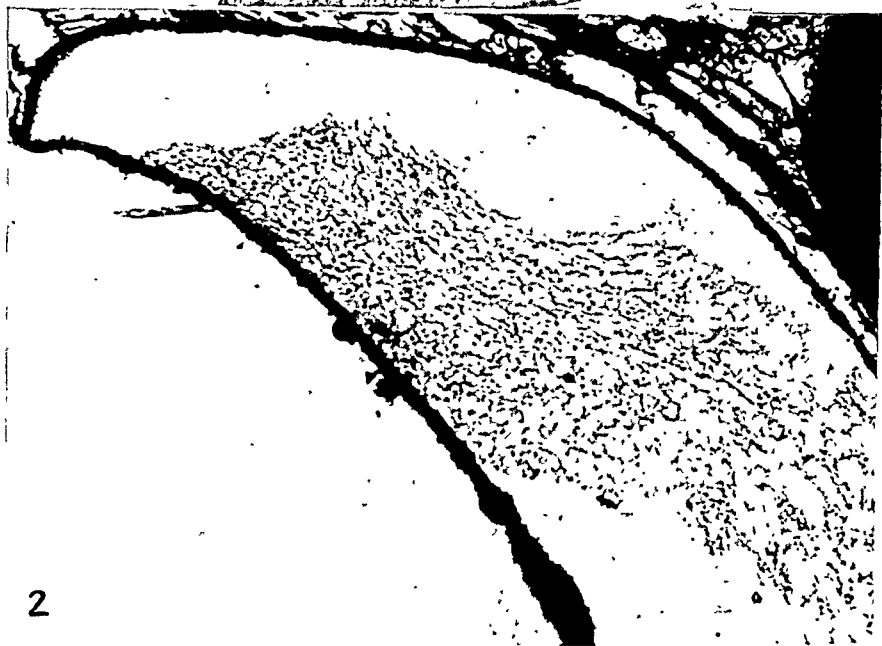


FIG. 4

Picture 1 shows a section through the utricle (u), the slightly dilated saccule (s), the macula sacculi (m) and the oval window (o) on the right side. Note the sero-fibrinous exudate (e) in all cavities of the inner ear. Picture 2 shows a part of the saccule in higher magnification. Note the network-forming exudate in the saccule.

Ménière's Disease

or permanent This, of course, does not explain the variability of clinical symptoms in vasomotor labyrinthitis, it rather furnishes evidence that accumulation of albuminous fluid in the internal ear does not invariably cause cochlear plus labyrinthine symptoms, regardless as to whether the abnormal permeability of the blood vessels is inflammatory in origin or not.

Conclusion

1 Ménière's disease is a type of labyrinthine deafness which is frequently progressive It differs from other types of progressive deafness by the fact that it is associated with attacks of labyrinthine dizziness and that there is no linear increase of deafness, there is rather a progress chiefly by means of attacks which cause a reversible or irreversible increase of deafness

2 The hydrolabyrinth in Ménière's disease is (as in other types of chronic progressive deafness) the eventual result of a serous labyrinthitis

3 In the absence of an infection of the tympanic mucosa or the meninges or the blood stream, the serous labyrinthitis may be—preliminary—termed "vasomotor labyrinthitis"

4 It is likely that there is invariably a vasomotor labyrinthitis or the result of it, viz, a hydrolabyrinth, if there is a Ménière's attack

5 Accumulation of albuminous fluid in the internal ear does not invariably cause cochlear plus labyrinthine symptoms, regardless as to whether the abnormal permeability of the blood vessels is inflammatory in origin or not

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S. Horowitz

On occasions the IIIrd, IVth, VIIth and VIIIth nerves have been involved. The involvement of the abducens nerve leads to the distressing symptom of diplopia. This symptom is surprisingly late in its appearance, and is uncommon in the early stages of mastoiditis. The average time is from 20-40 days after the onset of the infection of the ear. This delay is explained by Watkyn-Thomas as being due to isolated deep cells. There are innumerable gradations between the paresis and paralysis, but however severe the affection may be, recovery is generally complete, provided appropriate treatment has been carried out. The time required till normal function is restored varies from 2-4 months and is in exceptional cases as long as 6 months. Infrequently, nystagmus may precede or accompany the paralysis and occasionally photophobia is complained of by the patient.

In the typical uncomplicated case the temperature may remain normal throughout. If there is an elevation of temperature it ranges usually between 100°-102° F. A rise of temperature to 104° or 105° F. usually indicates the presence of a suppurative process extending inward to cause meningitis, extradural abscess or abscess of the brain.

According to Gradenigo, the syndrome is typically produced by an acute suppurative otitis media, but a great number of cases have been reported, in which the syndrome resulted from an exacerbation of a chronic purulent inflammation of the middle ear.

One case was reported, in which the female patient developed hirsutism and amenorrhœa in the course of petrositis, as a result of involvement of the contiguous pituitary body.

X-Ray Appearances

The radiological examination gives us information about the condition of the mastoid and apex of the petrous bone.

If X-rays are taken before operation, they show the type of pneumatization of the mastoid with the distribution of the cell system, the presence of infection, the condition of the apex whether cellular or acellular and the changes of the bone in an acellular apex.

If taken after operation, the radiographs show the type of operation carried out, the remaining cells and the state of the apex.

In a radiologically cellular petrous apex, they appear to be as those seen in mastoiditis in a cellular mastoid.

In a radiologically acellular petrous apex the appearances are those of an osteitis. In the early stages osteoporosis only may be found, in latter and late stages large defects with absorption and sometimes complete destruction of the upper contour may be found.

What applies to any radiological examination, applies here as well, viz., that positive findings are helpful, but negative findings do not exclude a pathological process (Bateman).

Etiology and Pathology

Scars, in an extensive survey of cases, summarized the etiology and pathology as follows: "The pathologico-anatomic process consists in a diffusion of the pus infection of the drum cavity to the pyramidal apex through the

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pertubal air-cells and the carotid canal The abducens is affected at the apex of the pyramid, close to its passage into the dura mater We have to deal with a circumscribed osteitis at the pyramidal apex and eventually with a corresponding pachymeningitis "

To understand the probable mechanisms, by which the VIth nerve becomes paretic or paralysed and why the patient experiences the agonizing trigeminal neuralgia, requires a detailed knowledge of the anatomy of the petrous apex.

From the lower border of the pons, the VIth nerve runs forwards along the base of the brain, till it pierces the dura mater of the cavernous sinus below the posterior clinoid process Here it is in intimate contact with the periosteum of the petrous pyramid

As it passes over the petrous pyramid it is particularly susceptible to infection at this point Dorello's canal, a narrow fibro ligamentous channel extends from the petrous apex and the posterior clinoid process of the sphenoid This canal is traversed by the abducens nerve on its way to the cavernous sinus Oedema of the lining of Dorello's canal, as it may be produced by any inflammatory process in this area or by extension of suppuration along the pneumatized petrous bone, leads to pressure on this nerve with consequent interference with its functions Even slight derangement in the area of the petrous apex will lead to partial or total loss of function to the VIth nerve, because of its close confinement in Dorello's canal

The pathology, which may lead to involvement of the VIth nerve, may be a localized meningitis, an extradural or brain abscess, or due to an extension of thrombosis from the lateral sinus into the inferior petrosal sinus, which joins the cavernous sinus at the site of entry of the nerve into the wall of this sinus

Meckel's dural cavity situated on the antero-superior surface of the petrous bone, contains the Vth nerve with its Gasserian Ganglion In this close confinement the Vth nerve can hardly escape any process in this region The close relation of the trigeminal nerve to the tip explains the pain, which characterizes the syndrome

Petrous invasion is more common in pneumatized than in diploetic or sclerosed temporal bones and then follows the usual mucosal spread as in the case of any other cellular mastoiditis

Coates, Erasner and Myers insist that true petrositis can only occur in a pneumatized temporal bone, but that this syndrome is independent of petrositis, as it may result from sinus thrombosis, extradural abscess or brain abscess, but that osteitis—true petrositis—may produce it

Many routes of transmission have been suggested from the middle ear cavity to the nerves involved but Profant has given probably the most comprehensive and concise description of the two routes of cells extending to the petrous tip the "antrum-epitympanic" and "hypotympanic" route

In the "antrum epitympanic route" the cells extend from the antrum and epitympanic space above the cochlea and above and behind the semicircular canal, then, behind, above and in front of the int auditory meatus, and, finally to the mass of cells under the tegmen of the anterior surface of the tip.

In the "hypotympanic route", the cells extend from the hypotympanic space, below the cochlea, then, below the int auditory meatus and finally to the mass of cells under the tegmen of the posterior surface of the tip.

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Examination of eyes.

Pareis of right VIth nerve. Visual acuity and visual fields normal. Fundus of right eye gross papilloedema (5 Diopters). Fundus of left eye normal. Nystagmus to left. Slight photophobia. Rest of C.N.S. normal.

Provisional diagnosis of extradural abscess was made.

7.12.47. Findings the same as on previous day, only the fundus of the left eye now showed even more papilloedema than the right and there were also small hemorrhages there.

The diagnosis of brain abscess was now in doubt, because of uncertainty of the diagnosis Ventriculography was carried out.

Findings at Ventriculography.

C.S.F. clear and under enormous pressure (400 mm. H₂O). Biochemical and bacteriological examination of the C.S.F. revealed no abnormality.

Ventriculogram. Ventricles were of normal width, no dislocation or local deformation of lateral or 3rd Ventricles.

Because of the normal cytology and the normal protein content of the C.S.F. and the normal appearance of the ventriculogram the diagnosis of brain abscess had to be abandoned and the diagnosis of Gradenigo's Syndrome complicated by "Otitic Hydrocephalus" was made.

9.12.47. It was decided to carry out daily lumbar punctures, in order to reduce the intracranial pressure. Mastoid wound clean.

11.12.47. Headaches less severe. Papilloedema of both eyes persisting. VIth nerve palsy persisting.

L.P. continued.

13.12.47. No change. L.P. continued.

21.12.47. Headaches still present, also VIth nerve palsy.

22.12.47. Mastoid wound clean and granulating well.

25.12.47. Area of skin where the L.P. were carried out slightly inflamed and tender. L.P. had therefore to be discontinued.

Because of the persisting papilloedema, a subtemporal decompression was considered.

As her visual acuity and visual fields were unimpaired, it was decided to wait and to observe further developments carefully.

29.12.47. Headaches almost absent. VIth nerve palsy improving. Papilloedema of both eyes as before.

4.1.48. No headaches for last three days. VIth nerve palsy greatly improved. No change in papilloedema, visual acuity and fields normal. Mastoid wound healed.

10.1.48. No headaches. Further improvement in VIth nerve palsy, sees double only occasionally. Papilloedema decreasing, cupping of disc returning. Hemorrhages in left fundus disappeared.

18.1.48. Papilloedema still regressing.

27.1.48. Eye movements almost normal. Further improvement of papilloedema.

2.2.48. Still slight papilloedema. VIth nerve palsy completely disappeared. Discharged.

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16.2.48. Attended as O.P. Fundi normal.

Eye movements normal. Had no further headaches. Mastoid wound remains healed and ear is dry.

CASE II.

Mrs. E.G., aged 30.

This patient came to the O.P. Dispensary on the 30.12.47.

History.

Patient had a discharging ear at the age of 13, but was completely free from any complaint until 4 weeks prior to her appearance at the O.P. Department.

It started with pain in her left ear, which was followed 2 weeks later by paroxysms of agonizing pain in the frontal region and in the depth of the orbit.

Four weeks after the commencement of the earache the patient started complaining of diplopia.

Aural examination.

Tympanic membrane. Small perforation in upper posterior part, the rest of the drum was thickened and there was a chalk patch in the antero-inferior quadrant. Small amount of discharge on the floor of the meatus.

No tenderness over mastoid process.

Rinne: negative. Weber: lateralized to diseased ear. Whisper voice heard at a distance of 4 inches.

The patient looked ill, the tongue was dry.

T. 98.6°. P. 120. R. 25.

Examination of the eye.

The diplopia was due to paresis of the VIth nerve of the left side. Fundi were normal, visual fields were full and visual acuity was unimpaired.

Examination of the rest of the C.N.S. showed no abnormality.

X-ray examination.

Both mastoids are well pneumatized with numerous large cells, which can be followed up into the petrous apex. There is cloudiness of the cells of the left mastoid and the cell walls are somewhat indistinct.

The diagnosis of chronic mastoiditis with acute flare-up, complicated by Gradenigo's syndrome was made.

3.1.48. Operation: Radical mastoidectomy.

There were masses of necrotic bone throughout the whole mastoid. A thorough exenteration was carried out and particular attention paid to the antral and zygomatic cells and the cells were followed towards the apex of the petrous bone. Small sinus exposure. Ossicles showed evidence of erosion and caries. Wound left open and packed.

4.1.48. Patient well. Headaches have disappeared, VIth nerve palsy persisting.

9.1.48. Wound clean and granulating well.

16.1.48. Patient's general condition very satisfactory, VIth nerve palsy still present.

28.1.48. Wound stitched. VIth nerve function gradually returning.

8.2.48. Mastoid wound healed. Ear dry. VIth nerve palsy greatly improved.

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17.2.48. Patient discharged. Patient sees double only very occasionally. To attend as O.P.

28.2.48. Seen in O.P. Department. The eye movements were normal. Patient very well.

Discussion

In the first case the picture of Gradenigo's Syndrome is to a certain extent obscured by the presence of the complicating "Otitic Hydrocephalus".

As mentioned previously the cause, leading to Gradenigo's Syndrome may be manifold and one has to look in this case for a pathology, which will explain both the Gradenigo's Syndrome and the Otitic Hydrocephalus.

It could be explained by the thrombosis of the lateral sinus, spreading along the inferior petrosal sinus, which connects the lateral sinus to the cavernous sinus at the site of entry of the VIth nerve into the wall of this sinus. This will lead to congestion, œdema and possibly to infection in the region of the petrous apex. The lining of Dorello's canal becomes œdematous and leads to compression of the VIth nerve, thus interfering with its function. The VIth nerve with the Gasserian ganglion confined in Meckel's dural cavity becomes also involved in this process.

On the other hand the thrombosis spreads from the lateral sinus along the transverse sinus to the confluens sinuum. From here it may spread along the straight sinus and lead to engorgement of the choroid plexus and increase in C.S.F. production.

Bedford, however, found it impossible to produce hydrocephalus in dogs and monkeys by occlusion of the Great Vein of Galen.

The more generally accepted theory in the production of O.H. is, that the spread from the transverse sinus follows the longitudinal sinus, blocking here the arachnoid villi, thus interfering with the absorption of C.S.F.

The longitudinal sinus goes into the right transverse sinus in a proportion of 7:3, a fact, which supports this theory, because O.H. occurs more frequently, when the right lateral sinus is affected.

It appears, therefore, conceivable, that the lateral sinus thrombosis was responsible for both conditions.

It is of interest, that the papilloœdema which was so marked, had not the slightest effect on the patient's visual acuity and visual fields. This has been noted also by other observers, and its importance lies in the fact that one does not need to take the step of decompression at an early stage in order to save the eyesight. If, however, the visual acuity undergoes progressive impairment, no time must be lost to carry out decompression, because it constitutes the only means to save vision (Cairns).

The second case gives Gradenigo's Syndrome in its common form, the spread occurring probably along the cells of the petrous bone to the petrous apex producing here a localized osteitis and pachymeningitis.

Summary

A review is given on Gradenigo's Syndrome with discussion of Incidence, Clinical manifestations, X-ray appearances, Pathology, Etiology, Prognosis and treatment available.

Clinical Record

Two cases are reported

The first is complicated by Otitic hydrocephalus and the most likely etiology is discussed

Treatment of OH by repeated L.P. is mentioned and subtemporal decompression was considered, but not found necessary

The second case shows Gradenigo's Syndrome in its common form

I am indebted to Mr Stephen Young, Senior Surgeon, in charge of the Department for his encouragement and helpful criticism, to Mr. Sloan Robertson, Neuro-Surgeon, for carrying out the Ventriculography, to Dr. Janet Steel, Ophthalmologist, for the repeated eye examinations and to Dr. T. Bryson, Superintendent, for permission to publish this paper.

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SOCIETIES' PROCEEDINGS

ROYAL SOCIETY OF MEDICINE—SECTION OF LARYNGOLOGY

March 5th, 1948

President—A. J. WRIGHT

Discussion on Malignant Disease of the Pharynx, excluding the Nasopharynx

By J. F. SIMPSON

Cancer in the laryngopharynx.—The gravity of this problem is shown in the report for 1945 of the Clinical Research Committee of the British Empire Cancer Campaign which states that out of 384 cases of laryngopharyngeal cancer only 19 survived the five-year period. Similarly in 1946 the Holt Radium Institute, Manchester, reported that out of 220 cases 9 cases survived the five-year period. It is because the symptoms are insidious that presentation is often late and to many palliation is all that can be offered. The early symptoms may be no more than a mild pricking sensation in the throat and slight muffling of the voice or a "catch in the swallow". An enlarged gland may be the first manifestation in pyriform fossa growths in as many as 25 per cent. of the cases. This symptomatology is in marked contrast to that of cancer of the vocal cords and is reflected in the expectation of cure.

When choosing between surgery and irradiation as the method of treatment it is sometimes difficult to suppress a personal bias, but it is essential that each case should be considered individually and not as a member of a group. The histology of the neoplasm and its operability are decisive factors in the choice of treatment. When the tumour is found to be of a type known to be especially amenable to radiotherapy the choice must be irradiation. Such tumours will include lymphosarcoma, reticulosarcoma, lympho-epithelioma and basal-cell carcinoma. These are more common in the nasopharynx and oropharynx but when occurring in the laryngopharynx generally originate in the vallecular region. These tumours spread early to the glands and the entire lymphatic field must always be treated at the same time as the primary focus.

Secondary growths are occasionally encountered in the laryngopharynx and require irradiation. The following three examples were recently encountered: an oat-celled bronchial carcinoma in the pyriform fossa which presented as the first evidence of malignant disease; a papillary carcinoma of the thyroid invading the posterior wall in a man of 21 in whom the primary growth had apparently been successfully removed a year previously; and thirdly, an example of a multicentric growth showing as scattered nodules. This was seen six months after the removal of a minute carcinoma from the floor of the mouth.

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The vast majority of tumours in the laryngopharynx are squamous-cell carcinomata and laboratory aids have not as yet superseded the clinical assessment in the decision as to choice of treatment. The grading of squamous-cell carcinoma as described by Broders may indicate the liability to metastasize but it appears to carry little weight to day in the prediction of the response of the individual tumour to irradiation. Even serial biopsy under irradiation is not without its errors. Constant clinical observation during and after treatment seems to be the only means of judging its effect. This is a matter of the utmost importance and should be carried out by the radiotherapist and the surgeon consulting together.

Inoperability is an indication for irradiation of carcinoma but this is a relative term as "inoperable cases in some hands become operable". Apart from the general physical condition and temperament of the patient the glandular metastases usually determine operability.

Current opinion seems fairly agreed upon the lines of treatment in regard to the glandular metastases. A search for glands should always be made during the excision of the primary growth even though none was detected on clinical examination. Where none is found and the excision is considered satisfactory, it is better to place reliance on post-operative observation than to embark upon immediate routine post-operative irradiation.

If the primary focus has been successfully treated by external irradiation through the gland fields but with failure to control the glands themselves these should be removed surgically if possible. The temptation to give a second course of therapy whilst they are still operable must be resisted. Thus whenever possible glandular metastases must be excised where the primary focus has been successfully treated, whether by surgery or irradiation.

Operations on the laryngopharynx are now largely standardized and during the last few years operative mortality has decreased with the introduction of chemotherapy and the antibiotics together with improved methods of anaesthesia. Other aids, such as continuous suction drainage and the use of semidigested protein foods to give a high concentration with tube feeding, may play a part.

The surgery may be divided into two types: (1) Simple excision without serious loss of structure or function, i.e., lateral transthyroid pharyngotomy, (2) large mutilating operations in which structures are sacrificed, i.e., pharyngolaryngectomy.

There is an intermediate group in which plastic procedures are necessary to make good the excised portion of the pharynx and to restore function.

When the neoplasm has invaded the framework of the larynx so that its removal is required, as much of the pharyngeal mucosa as possible is left so as to join the oropharynx with the oesophagus, but the entire segment of pharynx may have to be removed with the larynx. Recent American publications have stressed the necessity of removing the hyoid bone and tongue tissue above it in some cases to reduce the chance of recurrence in the pre-epiglottic space—a point too often disregarded here.

Because of the advanced state of the disease and poor condition of the patient when first seen irradiation and not radical surgery is the treatment more frequently applied. Furthermore, irradiation can be applied to almost

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every case, but this must not be taken to mean that irradiation is the only form of treatment for cancer of the laryngopharynx, a belief too prevalent to-day. Radiotherapists recognize that the response to irradiation varies at the different sites in the laryngopharynx and comparatively good response is expected in the vallecula, epiglottis and aryepiglottic fold but the black spots of the laryngopharynx are the pharyngeal wall, pyriform fossa and the post-cricoid region.

This clinical fact must always be taken into consideration when planning treatment and will naturally give bias towards irradiation in the favourable sites. It is in these same places with the exception of the vallecula that the more limited form of surgery may be applicable when the growth is small. The choice between such surgery and irradiation as a first line of treatment in these cases is a difficult one. Every aspect of each case must be weighed, the selection being highly individual and set rules cannot be applied. It is in these positions that a carefully watched therapeutic trial of irradiation may yield good results, especially when the growth is superficial and non-infiltrating. If a full course fails to produce complete disappearance of the cancer a second course will not produce a cure. It follows, therefore, that as soon as irradiation is thought not to be controlling the disease urgent consideration must be given to the possibility of radical surgery. This revision of treatment may supply the last and only chance of prolonging life, apart from a possible cure.

The formidable nature of the operation of median translingual pharyngotomy together with the fair expectation from irradiation rules out surgery for vallicular growths. It is rare for pyriform fossa and post-cricoid carcinomata to be suitable for local excision but when such surgery is possible it should be given every consideration on account of the unfavourable response to irradiation at these sites.

Once any carcinoma of the laryngopharynx is thought to have invaded the cartilage of the larynx, with the exception of the free portions of the epiglottis, it is best to give first place to surgery even though this means pharyngolaryngectomy. All these decisions are of course made in the light of the state of the lymphatic glands, etc. They should not be made by the surgeon or radiotherapist working alone but as a team in which consultation results in planned attack. Furthermore, observation after operation or radiotherapy forms one of the most important responsibilities which this team must undertake.

Statistics have been avoided as almost every individual case must in the end require a separate category and this makes comparison dangerous, but some figures must be quoted to appreciate the degree of success which may be obtained by surgery. Lionel Colledge was able to state in his Lettsomian Lecture, Medical Society of London, 1943, that 13 out of 39 patients (33 per cent.) were well ten years after lateral pharyngotomy and 6 out of 16 cases (37 per cent.) for a similar period after pharyngolaryngectomy. These figures undoubtedly represent the peak to which this branch of surgery has been brought. Last year Orton of Newark presented to the American Laryngological Association a series of 51 cases of pharyngeal carcinoma in which surgery was the method of treatment and resulted in 27 per cent. of five-year cures.

In the British Empire Cancer Campaign already referred to there were 49

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cases in which there were no glandular metastases or invasion of the adjacent tissues. Of these only 2 were subjected to radical surgery (pharyngotomy). The two cases which received surgery survived the five-year period and 6 out of the 47 which received irradiation (13 per cent)

The treatment of cancer of the laryngopharynx must be carried out by a team. The possibility of good surgical results in suitable cases must be remembered in view of the Cancer Act. If this Act means that patients are to be sent direct to the radiotherapist without the benefit of surgical opinion it will be a sad thing, but if it means consultation and following up by a team then we may reasonably expect improvement in results in the integrated use of the only two weapons at our disposal (See MS of cases shown herewith)

R S PILCHER. In 100 consecutive cases of cancer of the pharynx admitted to University College Hospital there were 70 men and 30 women. Men had a maximum incidence at 60-64, women at 50-54. In 29 women the growth was post-cricoid, in 1 woman and 70 men the growth was epilaryngeal. In the epilaryngeal group two sites are important, the pyriform fossa because of its frequency (42 cases), the lateral wall because it is the most favourable for conservative surgery (9 cases). Observations on the symptoms show further distinctions between the epilaryngeal and post-cricoid groups. Dysphagia was the first symptom in 11 women, but only 10 men. It was, however, the dominant symptom on admission in 25 women and 32 men, the average duration of symptoms before admission being eight months. Enlargement of cervical glands was the first symptom in 22 men, but only 1 woman. While it is true that the post-cricoid growth is less likely to be symptomless than one in the pyriform fossa and, therefore, more likely to be noticed before it has metastasized to glands, it also appears that the former metastasizes less rapidly than the latter. Even a large post-cricoid cancer with over a year's duration may remain localized to the primary site. The distinction is important for in the epilaryngeal group it is often the glandular metastases that determine inoperability, while in the post-cricoid it is usually the local spread of the primary. Gland dissection should always form part of the surgical treatment of the epilaryngeal growth, but may sometimes be omitted in the post-cricoid. Common to the symptoms of both groups is the onset with some abnormal but trivial sensation in the throat. These sensations, which are variously described by the patients, were the first symptoms of the disease in 30 men and 13 women. Suggestive of cancer, when a patient complains of an abnormal sensation in the throat, is its definite localization and its persistence. Indirect laryngoscopy for any persistent localized discomfort in the throat is the most promising contribution to early diagnosis of cancer of the pharynx.

Of the 100 cases, 49 were judged to be operable—35 men and 14 women. Estimates of operability vary widely, but that this series is not a particularly favourable one is suggested by the need for emergency tracheotomy or gastrostomy, or both in 25 cases, apart from the use of these measures as part of radical treatment. Radical operations were completed in 25 men and 14 women with 9 operative deaths in the former and 7 in the latter. 4 men and 3 women survived five years or more without recurrence, the shortest observed period being five years, the longest fourteen years. All operations were of the conservative type and the series includes no example of pharyngolaryngectomy.

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The chief cause of mortality was sepsis and none of the operations in the series was performed later than 1935 when the benefits of chemotherapy were not available. In addition to the cases treated surgically there were two survivals of five years or more after irradiation—both being operable cases. One of these had repeated local recurrences before five years and died of the disease. The total of five-year survivors out of the 100 cases was, therefore, 9 and of these 8 survived five years or more without recurrence.

The aim of the conservative operation devised by Wilfred Trotter is to remove the growth and to preserve the functions of the larynx and pharynx. It is sometimes possible, particularly if the growth is on the lateral wall, to reconstitute the pharynx by simple suture of the defect, but usually a 2-stage operation with replacement by skin is necessary and incisions are planned with this in view.

For post-cricoid tumours excision of the whole circumference of the pharynx is usually necessary and to replace this the incisions outline a rectangular flap, with its free end in front, which will, at the second stage, be rolled into a tube. From the base of the flap the incision is continued up to the mastoid and down to the clavicle.

For the epilaryngeal tumours smaller areas of skin replacement are needed and flaps hinged on the muco-cutaneous junction made at the first stage are adequate. The skin that is turned in at the second stage to form new pharyngeal wall should be taken from below the lower edge of the beard. The main skin incision for epilaryngeal growth should be a curved one across the neck just below the beard line. From the centre of this another incision can be made down to the clavicle. When the pharynx is closed no skin for turning in should be taken from above the transverse incision. After the skin incisions have been made according to the expected plan of reconstruction and flaps raised the next step is the gland dissection. The sternomastoid is usually retained and is sutured to the prevertebral fascia in front of the carotid sheath to afford the latter some protection from infection. To expose the pharynx, one-half of the thyroid cartilage is removed and sometimes half the hyoid bone. If the growth involves the thyroid the ala is not completely removed, but is left attached after division of the cartilage in the mid-line. The pharynx is opened at any convenient point at least a centimetre from the edge of the tumour as determined by palpation, and from this opening excision is completed with the pharyngeal aspect of the growth in view. If a post-cricoid growth encircles the pharynx separate openings must be made above and below. After excision of the growth mucosa is sutured to skin all round the defect, making a single stoma for an epilaryngeal growth and usually a double one for a post-cricoid. It is not always possible to determine operability until the pharynx is opened. If after opening the pharynx it does not appear possible to perform a conservative excision a pharyngolaryngectomy may be done with the first stage of reconstruction of the pharynx and the formation of a permanent tracheotomy.

Some details of the successful cases deserve comment. In the first place all 5 epilaryngeal cases had involvement of cervical glands. In 4 the gland dissection was done at the same time as the pharyngotomy and in 1 four weeks before. The experience of this small series certainly lends no support to the

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opinion that if glands are involved radical operation is not worth attempting. In 3 cases the pharynx was closed by primary suture and in 2 a fistula was made and closed at a second stage. In spite of these successes with primary closure, Trotter's final opinion was that a fistula should always be made at the first operation as a safeguard against sepsis.

In 1932 Trotter published 6 other cases of survival without recurrence for five years or more—the longest being twenty years so that from one hospital we have knowledge of 13 successful radical operations. When one considers the perseverance of surgeons in other fields such as cancer of the œsophagus and lung it is surprising that so little is being attempted for cancer of the pharynx. The greatest obstacle to success in the past was infection, and in penicillin and sulphonamides we have the means of controlling this risk. In addition to chemotherapy there have been advances in the knowledge of anæsthesia and nutrition which should further increase the margin of safety. The time is ripe for surgeons to apply these new resources to the surgery of cancer of the pharynx and to make fresh efforts to treat this distressing disease.

GWEN HILTON: *Carcinoma of the pharynx*.—In the Radiotherapy Department of University College Hospital during the years 1942 to 1946 inclusive, 89 cases of pharyngeal growths were seen.

Of these 89 cases, 7 were considered too ill for any form of treatment, and 6 were treated by surgery alone.

One great difficulty in comparing the results of treatment of cancer of the pharynx is that of the exact diagnosis of the site of the growth. In most of the cases seen, the growth was so advanced that the whole of one side of the oro- or hypopharynx was involved. A growth which is confined to the pyriform fossa or aryepiglottic fold, or a tonsillar growth which has not invaded the neighbouring tissues is rarely sent for radiotherapy. Sometimes, however, as the growth shrinks under treatment, it is possible to be fairly certain of its actual site of origin. The cases have been divided up into those having growths arising in the oropharynx, the hypopharynx and the post-cricoid region. There were 16 cases with growths in the oropharynx, 63 cases with growths in the hypopharynx and 10 cases with growths in the post-cricoid region. To give an idea of the extent of the primary growth they have been divided into two stages: Stage I included cases in which the growths were confined to the tissue of origin. Stage II included cases in which the growths had become diffuse and spread from their point of origin to involve other pharyngeal structures.

Only 13 cases of the whole 76 were included in Stage I. The remaining growths were Stage II. It was surprising to find that no glands were palpable in 17 Stage II cases although the primary had involved the whole or part of one side of the oro- or hypopharynx. In 25 of the Stage II growths, however, there were large masses of matted glands in the neck.

It is seen from this that most of the growths were advanced. They are a discouraging group of cases, only a small number of them offering even a chance of cure.

The usual duration of symptoms before the patient was first seen was three to four months, but a few patients gave quite long histories of twelve to eighteen months, and this raised the average duration of symptoms to six

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months. The duration of symptoms in cases with widespread growth was usually short, suggesting that in advanced cases the progress of the disease was more rapid from the beginning. A biopsy was done in 73 of the 89 cases. All the 16 cases where no biopsy was taken were advanced, and there was no doubt as to the clinical diagnosis. All the hypopharyngeal growths from which a biopsy was taken were squamous carcinomas, except one, in which parts of the section suggested a lympho-epithelioma.

The growth in the hypopharynx of one case which was demonstrated at the meeting was a fibrosarcoma. It was not included in this series, as the treatment was only carried out in 1947. The immediate response of this tumour to irradiation was good. The biopsies of tumours arising in the oropharynx showed not only the more usual squamous carcinomata, but also some tumours of lymphatic origin, under which term are included the reticulum-cell sarcomata, the lymphosarcomata, etc.

The histological picture before treatment did not always help in the prediction of the response to irradiation. Histologically identical growths may respond differently to irradiation according to the tumour bed from which they arise. For instance, one sees cases of carcinoma of the tonsil which have extended a few millimetres into the base of the tongue. The response of the growth in the tonsillar fossa has been most successful, but the response, with identical dosage, of that portion of the growth invading the tongue has been poor, and active growth has persisted there. This difference in response can only have been due to the difference in the tumour bed.

With reference to tumours of lymphatic origin. Although there are not a large number of them it is important that they should be recognized as their treatment and prognosis are different from that of the squamous carcinomata.

Any of the members of the group of lymphomata, such as lymphosarcomata, reticulum-cell sarcomata, may give rise to tumours in the oropharynx. They may cause diffuse enlargement of the tonsil similar to ordinary tonsillar hypertrophy. The tumour projects from the tonsillar fossa as a rounded or irregular-shaped mass which may attain a considerable size.

At first the tumour does not appear to infiltrate the surrounding tissues. As the tumour progresses, it infiltrates the pillar and encroaches diffusely upon the soft palate. It may also extend into the base of the tongue. There may be superficial ulceration. The consistency of the tumour is harder than normal tonsil, but usually it is softer than carcinoma. The metastases in the cervical glands are comparatively soft and isolated in the beginning. They become fixed to surrounding tissues at a fairly early stage, but they are rarely adherent to the skin.

A lymphoma in the pharynx is only one manifestation of a generalized disease. The disease may remain localized in the throat for some months, or even many years, but sooner or later enlarged glands will appear elsewhere in the body, such as enlarged axillary or inguinal glands, or enlarged mediastinal or abdominal glands; or deposits may arise in the liver, spleen or bones. It is important to realize the widespreading tendency of this growth from the very first. A complete examination of the patient should therefore be made. So often one is asked to treat a patient with a tumour in the pharynx and on

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examination one finds enlarged glands elsewhere in the body. Naturally it is useless to treat the tumour in the throat only.

(A table of the age-incidence in the 89 cases was shown.)

Most of the patients were between 50 and 80 years of age. There were relatively few under 50. There were more males than females. 10 of the 20 women had post-cricoid carcinoma.

In deciding between operation or radiotherapy, all patients were seen by both the surgeon and the radiotherapist, and the various methods of treatment discussed.

Cases of cancer of the pharynx with an operable tumour can be treated and cured by the operation of lateral pharyngotomy or pharyngolaryngectomy. The majority of cases, however, referred to the radiotherapist are already inoperable; or if they have an operable tumour, their general condition is too poor to stand a big operation. During the last three years, any operable cancer of the hypopharynx, including the post-cricoid cancers, was operated on if the patient was in a fit condition to stand an operation. The number of cases treated by surgery alone show how few were considered suitable for operation.

Inoperable cancers of the hypopharynx were treated by radiotherapy. Squamous carcinomata of the oropharynx were treated in one of two ways. In a few cases part or the whole of the tumour was removed by diathermy and then X-ray treatment was given, and in the other cases irradiation alone was used. All tumours belonging to the malignant lymphomata group were treated by radiotherapy alone. We do not consider that they are suitable for surgery, since they are only one manifestation of a generalized disease, and we consider there is a risk of general dissemination of the growth if the tissues are cut into. These tumours are all radiosensitive.

Great care was taken in planning the technique of irradiation treatment, especially in estimating the extent of the growth. It is of utmost importance to know the limits of the growth, otherwise the area of irradiated tissue may be inadequate and parts of the growth may be untreated.

Œsophagoscopy and direct laryngoscopy are usually necessary to determine the full extent of the growth, and even then it may be impossible to pass the œsophagoscope beyond the growth and find the lower end. A lateral straight X-ray of the soft tissues of the neck either with or without barium in the pharynx or cervical œsophagus, and also tomographs may be of immense help, particularly in post-cricoid cancers.

One of the chief hindrances to the successful treatment of cancer of the pharynx is sepsis. Sepsis not only renders the growth more radioresistant, but makes the patient more likely to succumb to some infection of the lungs, such as bronchopneumonia. It is frequent for a frail elderly patient to develop a low-grade bronchopneumonia during the course of X-ray treatment.

Every means should therefore be taken to eliminate all septic foci in the mouth—teeth should be removed and infected gums treated. Penicillin either in the form of lozenges, sprays or injections should be employed to deal with the infection on the growth itself. We often spend a week or more dealing with the infection before beginning irradiation, and find the time well spent.

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In addition the general condition should be improved as much as possible. The cancer patients having radiotherapy require the same careful general treatment as do those having, for example, a partial gastrectomy. The medical and nursing care of the patient before and during the treatment is most important. Since the growth frequently causes great difficulty in swallowing, the patient is often thin, wasted and anæmic from lack of adequate nourishment. If solids cannot be swallowed, a high calorie fluid diet must be given, and the vitamin content must be considered. If the patient cannot take adequate nourishment by mouth, a gastrostomy must be considered. This should be carried out before the treatment is begun, since it is unwise to interrupt a course of irradiation in the middle. Similarly, if a tracheotomy is indicated, it should be performed before beginning treatment. Any anæmia should be treated by full doses of iron, and in some cases by transfusion. The progress of patients often depends on building up their blood.

During the course of the treatment there is bound to be a severe reaction of the mucous membrane of the throat if adequate irradiation is given—and the patient will then need most careful nursing. Much can be done to alleviate the pain and soreness in the throat by giving tablets, such as benzocaine tablets, to suck before meals, or benzocaine emulsion to sip during the meals and aspirin sprays and gargles in between.

What benefit has the radiotherapy been to the patient? 15 out of the 71 cases which had a complete course of X-ray treatment are alive now. The average duration of life of the 71 patients was 18.4 months. The average duration of the 15 patients who are alive now is 35.6 months. The longest survival in this group so far is five years eight months. The growth in this case was confined to the epiglottis. It is interesting to note that the 3 cases in which the growth was confined to the epiglottis and aryepiglottic fold are alive. The longest survival period is five years eight months, the second four and a half years and the third two and three-quarter years.

The prognosis of the tumour of lymphatic origin, such as the lymphosarcomas and reticulum-cell sarcomata, which have infiltrated the surrounding tissues, appears to be better than the carcinomata when these have spread beyond the tissue of origin. One of the patients in whom the tumour had spread from the tonsillar fossa on to both pillars of fauces, the soft palate and down the pharyngeal wall has so far lived four years three months, despite the infiltration of the surrounding tissues. The section showed a stem-cell sarcoma.

The average duration of life of 18.4 months may not show a great prolongation of life, but I do not think one should only consider the duration of life of the patient when one is trying to assess the benefit which may be derived from any form of treatment; but one should also consider whether palliation is achieved and whether the patient is free from pain and able to work. We have only considered the disease to have been palliated by treatment when both the primary growth and the enlarged glands in the neck have undergone at least 50 per cent. diminution in size, when the patient's symptoms have improved sufficiently for him to say that he really feels better and able to work, and has gained weight. In quite a large proportion of the cases we did achieve palliation, but in a number it was short-lived, especially in many of the 25

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cases which had a huge projecting mass of matted glands in the neck. The treatment in these cases was a failure because the improvement was so short-lived. The average duration of life in these 25 cases was only 7.7 months. The mass of glands in the neck was greatly reduced in size, but a hard residuum usually remained which sooner or later caused severe pain, almost impossible to relieve. Only very occasionally did the matted masses of glands resolve completely. In such cases with extensive secondary masses in the neck, therefore, it does require considerable judgment to decide whether or not radiotherapy is worth while.

There is a second category in which this decision may also be difficult. That is when clinical cachexia is prominent and when the sepsis in the throat does not clear up with preparatory treatment. In the first place irradiation is never successful in the presence of uncontrolled sepsis and, in the second place, it is difficult to prevent lung infections which are apt to be fatal. Real palliation was, however, achieved in many of the remaining cases. Unfortunately, one can rarely say beforehand from the clinical examination, plus the plain histology, that is without special cytological counts, whether or not the treatment will be successful. (MS of cases shown herewith.)

LIEUT-COLONEL W. L. HARNETT (Medical Secretary to the Clinical Cancer Research Committee of the British Empire Cancer Campaign), presented statistics showing the results of treatment in 511 cases of primary pharyngeal cancer, collected by the Committee from all the London hospitals between April 1st, 1938 and September 3rd, 1939 and published in the 22nd Annual Report of the B.E.C.C. for 1945. 127 cases of primary cancer of the tonsil had since been added to the 384 cases of cancer of the other regions of the pharynx. Table I gives the anatomical distribution and sex incidence.

TABLE I

No	Percent	Region	Males	Females	Males as per cent of group
127	24.9	Tonsil	115	12	90.6
63	12.7	Vallecula and Epiglottis	61	4	93.8
31	6.1	Posterior Wall of Pharynx	18	13	58.1
46	9.0	Aryepiglottic folds	42	4	91.3
149	29.2	Pyramidal fossa	137	12	91.9
90	17.6	Post-cricoid	22	68	24.4
3	0.6	Site not stated	3	—	100.0
511	100.1		398	113	77.9

Mean ages: Males 62.4-65.6 years
Females 52.1-56.8 years

The 90 cases of post-cricoid carcinoma included 25 in which it was impossible to be sure from the data on the case sheets whether the growth was original in the hypopharynx or in the upper oesophagus, if these were the original sites. The percentage of males in this group would be 16.9. The ages of males and females were statistically significant in .

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pyriform fossa 12.6 ± 2.3 , and the post-cricoid 8.8 ± 1.9 . The cases were grouped as follows:

TABLE II.
STAGES

		No.	Per cent.
Stage I	Confined to tissue of origin, lymph nodes not involved clinically	58	11.4
Stage II	Adjacent tissues invaded, but nodes not involved clinically	96	18.8
Stage III	Lymph nodes involved clinically:		
	(a) Without invasion of adjacent tissues	106	
	(b) With invasion of adjacent tissues	238	
		344	67.3
Stage IV	Remote metastases present	12	2.3
	Not staged for lack of data	1	0.2
	Grand totals ..	511	100.0

The methods of treatment used and the results are shown in Table III.

TABLE III.
METHODS OF TREATMENT AND RESULTS

	No.	Operation fatalities	Survived 5 years	Died with cancer	Died without cancer	Not traced	Survival percentage
SURGICAL							
Radical surgical ..	27	4	6	16	—	1	22.2
Combined surgical and radiotherapy ..	7	—	2	5	—	—	28.6
Palliative surgical alone	28	10	—	18	—	—	—
RADIUM							
Interstitial radium ..	6	—	—	6	—	—	—
Teleradium or surface Ra.	115	—	12	95	7	*1	10.4
Teleradium and palliative surgical ..	13	—	—	13	—	—	—
X-RAYS							
X-rays alone ..	208	—	14	191	1	2	6.7
X-rays and palliative surgical ..	19	1	—	18	—	—	—
X-rays or teleradium with interstitial radium ..	12	—	—	12	—	—	—
Not treated by surgery or radiotherapy ..	76	—	—	76	—	—	—
	511	15	34	450	8	4	607

* Known to be alive at $4\frac{1}{2}$ years.

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The five-year survival rate by anatomical regions and stages are shown Table IV

TABLE IV
SURVIVAL RATE BY STAGES AND REGIONS

	Stage I		Stage II		Stage III		Stage IV		Not staged	Total	Per cent
	S		S		S		S		S	S	
Vallecula and epiglottis	9	-	10	-	45	3	1	-	-	65	4 6
Posterior wall of pharynx	3	2	3	-	25	3	-	-	-	31	16 1
Ary epiglottic folds	7	2	8	1	28	-	3	-	-	46	6 5
Pyramidal fossa	14	3	21	1	111	1	3	-	-	149	3 4
Post-cricoid	16	1	30	1	44	1	-	-	-	90	3 3
Tonsil	9	2	23	7	89	6	5	-	1	127	11 8
Site not known	-	-	1	-	2	-	-	-	-	3	0 0
Totals	58	10	96	10	344	14	12	-	1	511	6 7
Percentage survived	17	2	10	4	4	1	0	0	0	0	

A method of estimating the five-year survival rate by comparing the mean actual survival time in months with the mean expected survival for five years of a group of the general population having the same age-sex constitution was then explained. Expressing the mean of the actual survival times as a percentage of the mean expected survival times, the results of treatment are shown in Table V. This method gave a more accurate assessment of the prolongation

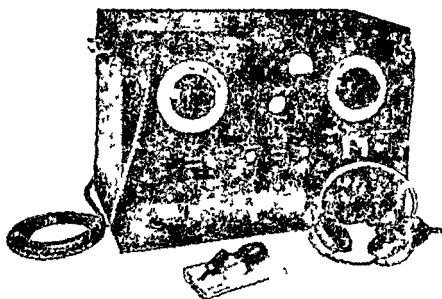
TABLE V
ACTUARIAL ESTIMATION OF SURVIVAL

		Stage I	Stage II	Stage III
RADICAL SURGERY WITH/WITHOUT X RAYS				
Mean number of months survived	No	5	5	22
Per cent of Expected		42 0	29 8	25 6
		82 4	53 6	46 5
TELURADIUM				
Mean number of months survived	No	12	24	69
Per cent of Expected		36 9	29 5	20 4
		68 3	55 4	37 9
X RAYS				
Mean number of months survived	No	25	28	144
Per cent of Expected		24 2	20 6	16 9
		44 9	38 7	34 3
		All stages		
NOT TREATED BY SURGERY OR RADIOTHERAPY				
Mean number of months survived	No	67		
Per cent of Expected		7 8		
		15 3		

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of life by treatment than the crude survival rate, as it took account of deaths from other causes than cancer during the period of observation.

MR. V. F. LAMBERT said that in Manchester, judged by the five-year survival rate, their results were terribly distressing. The best results they had actually obtained were in post-cricoid carcinoma, using the specialized technique of the bougie and the radium collar. But taking 100 cases of post-cricoid carcinoma alone the five-year survivals were only 7 per cent. The picture was very depressing, and he was particularly happy to think that his surgical colleagues that day had given them new hope that by improving their study of technique they might at any rate approach the figures which the radiation people had already reached.



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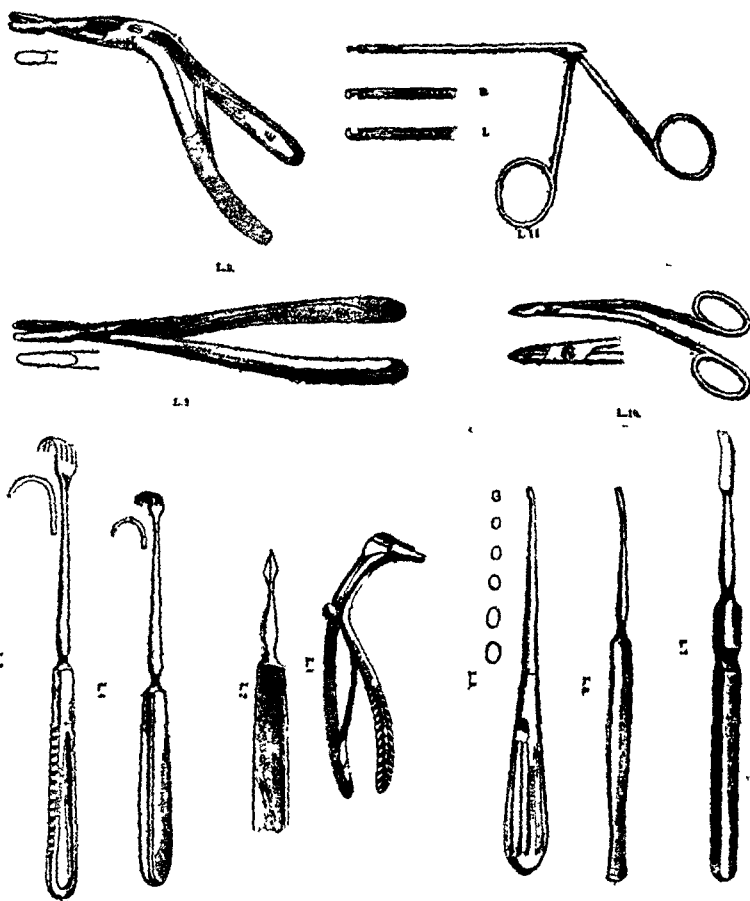
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WITH THE ASSISTANCE OF
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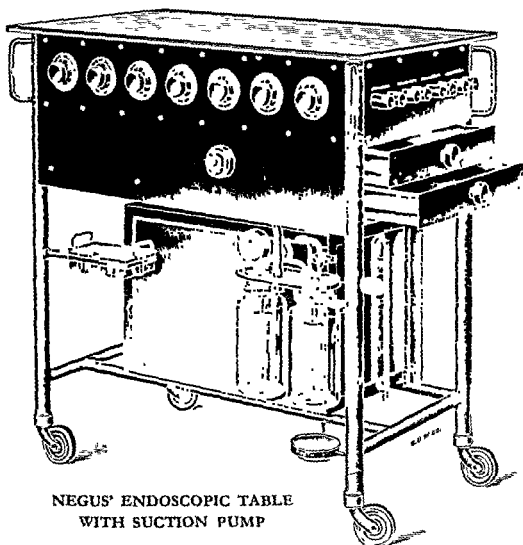
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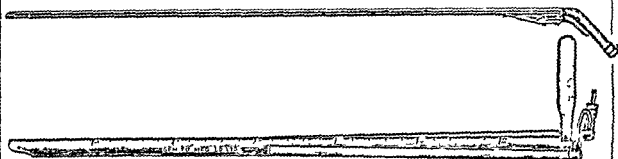
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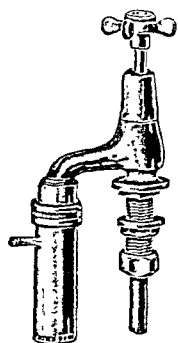
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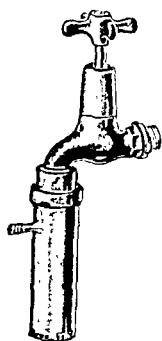
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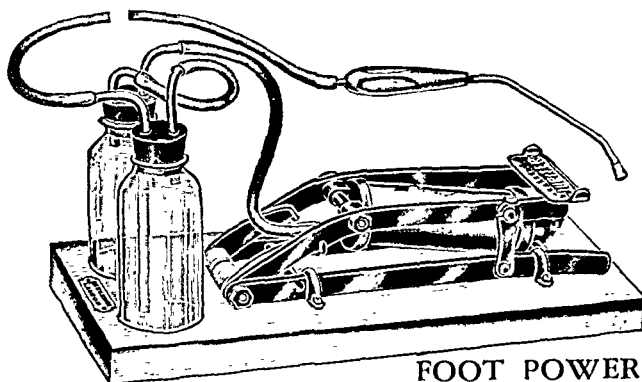


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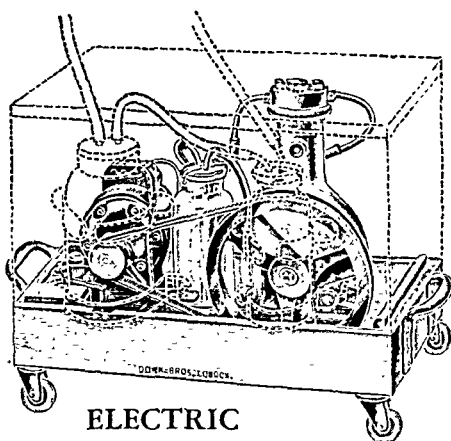
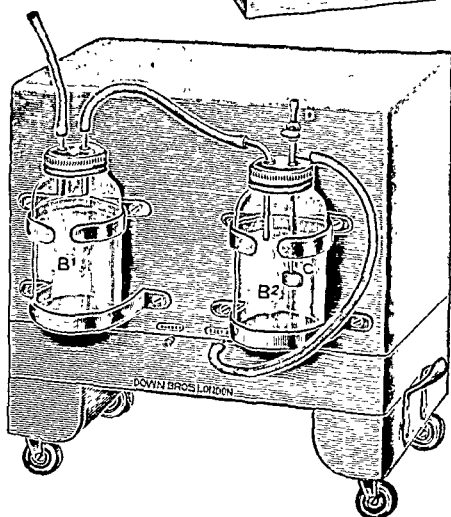


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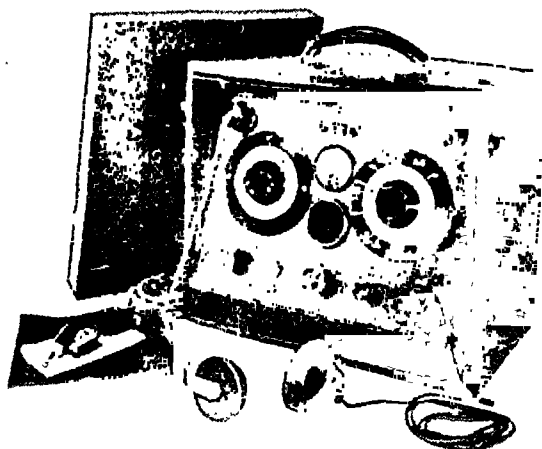
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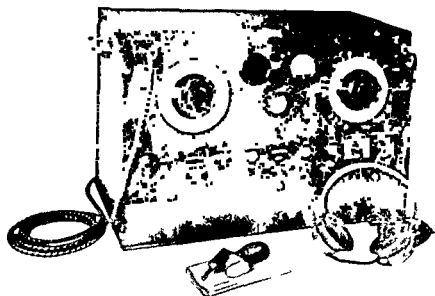
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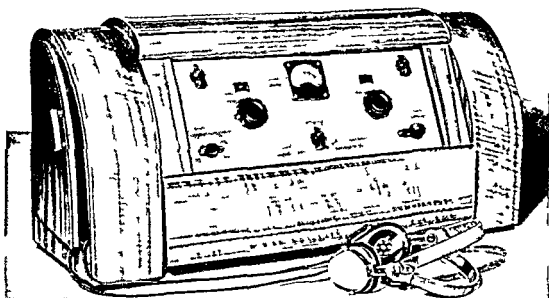
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OTOSCLEROSIS IN CHILDHOOD

By WILLIAM MCKENZIE (London)

OTOSCLEROSIS in childhood is unusual, but it is not rare. At the Deafness Clinic of the Middlesex Hospital eight patients of a total of 300 suffering from otosclerosis gave a history of deafness before the age of fifteen.

Guild¹ has shown that in 589 normal subjects, 44 had a focus of otosclerosis in the temporal bone, and of these four were under fifteen years of age.

In his original paper, Guild draws a distinction between histological and clinical otosclerosis, but there is probably a fixed relationship between these two conditions.

If this relationship is granted, the proportion of cases with clinical otosclerosis who are under fifteen years of age will correspond with the proportion Guild found with histological otosclerosis. Taking his figures therefore, of four in 44 cases, or roughly 9 per cent, we should expect 27 of our 300 deaf patients to have dated their affliction from childhood.

That we have only eight is due perhaps to the difficulty of diagnosis. Repeated examinations over a period of years may be necessary before the diagnosis of otosclerosis can be made in childhood, and this is not possible in a busy clinic.

Diagnosis

Everyone who examines children for deafness knows how difficult it is to make a diagnosis. Indeed the younger the child, the more difficult is it to be sure that he is deaf at all.

We were fortunate that deafness was the complaint in all three of the cases recorded, but usually the parents complain of disobedience and inattention in their child rather than deafness.

The child will not, of course, complain of deafness, presumably because he cannot remember hearing well and so has no standard of comparison.

William McKenzie

The history depends on the accuracy of the parents' observation, and there is no question which can be put to the child which is likely to produce a helpful answer.

A family history of deafness may suggest otosclerosis but it can do no more, while a story of repeated deafness with colds is so often due to infected adenoids in childhood that it is no evidence of otosclerosis.

A child who has been noticeably deaf for some years, and who has become deafer without earache or otorrhœa, should be suspected of otosclerosis, for profound deafness is unusual in a nasopharyngeal infection, and perceptive deafness does not increase steadily.

Examination : While the history is taken from the mother, the child should be watched. After a few minutes, it will be clear whether he can hear ordinary conversation or not. If he can hear, he will listen to something his elders say, and show quite clearly that he is listening, even if the bulk of the conversation is too boring to be worth attention.

At this point, a few simple questions can be asked the child, such as " How old are you ? " and " Where do you live ? "

A child who speaks normally, and more, who speaks with a local accent, has not been deaf in infancy when it has learnt to speak. Therefore, by this test alone the majority of cases of perceptive deafness can be excluded.

Examination of the ears may show no change, or the drums may be indrawn.

The nose and throat may show signs of chronic infection, but it must be remembered that a child who is deaf from otosclerosis may have infection of the tonsils and adenoids as well.

The success of more formal tests of hearing depends on the age. Under seven years, accurate tuning fork tests are not possible, and we have not been able to make a diagnosis of otosclerosis before this age.

A negative Rinne for 256 and 512 cycle tuning forks on several occasions, with a profound loss of hearing, should suggest otosclerosis, especially if the tuning forks are heard normally in the centre of the forehead.

A valve amplifier is a great help in diagnosis, but it must be used carefully. Deaf children are natural lip-readers, and when any test of hearing is made, the lips of the speaker must be hidden. However, if a child who is deaf to ordinary conversation speaks normally, and can understand speech with a valve amplifier, the diagnosis is a conductive deafness.

Audiograph : The air conduction audiograph in the children whose case histories are recorded, shows a characteristic curve. The loss is greater than is found usually in deafness from adenoids, and the shape corresponds to that which may be expected in young people with otosclerosis.

Otosclerosis in Childhood

The bone conduction audiograph is, of course, not so reliable, but the good hearing in each case suggested a conductive deafness.

Removal of adenoids Diagnosis of otosclerosis is so difficult in a child, that the distinction from middle ear deafness due to adenoids may be impossible. In all our cases the postnasal space was examined and adenoids removed in the course of the investigations.

Observation Repeated audiographs at intervals of three months may make the diagnosis clear. Deafness from adenoids is not likely to become profound, and it may disappear spontaneously, while deafness from otosclerosis will either remain the same or increase, it will not improve.

Differential Diagnosis

Adenoids Something has been said of this already, and it is certainly easier to diagnose deafness from adenoids than deafness from otosclerosis. In the first place the deafness is less. The speaking voice is heard at a distance of a foot from the ear at least, while the normal distance is

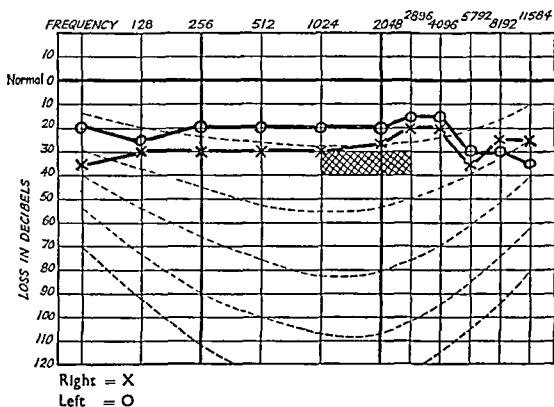


FIG. 1
T H Deafness due to adenoids

twenty feet. When the deafness is greater there is nearly always a recent acute infection to explain it.

The air conduction audiograph is of the shape shown above (Fig. 1). The loss is seldom more than 35 D.B. at any frequency and the loss for hearing to high notes is equal to the loss to low notes, if it is not greater.

William McKenzie

Finally, removal of adenoids will restore the hearing within a month or six weeks (Fig. 2).

Examination of the nasopharynx with a mirror is often difficult in a child, and may be impossible, so that if there is any doubt about

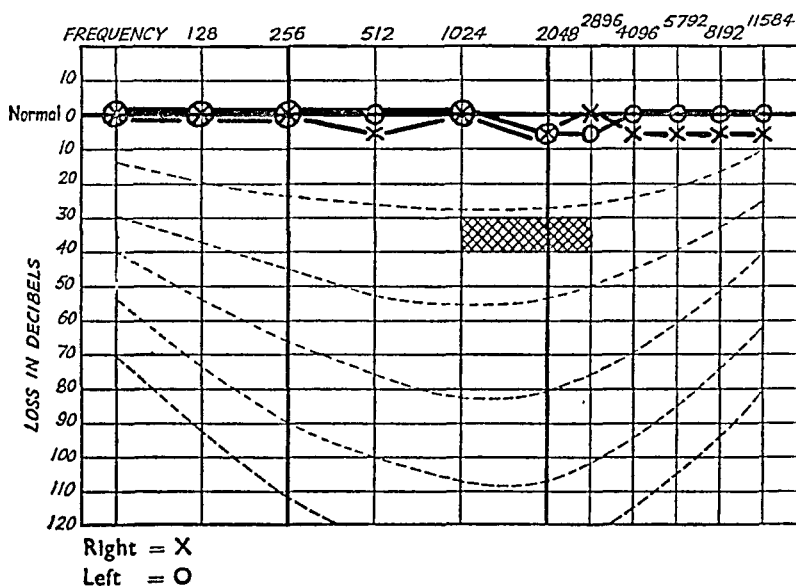


FIG. 2.

T.H. Hearing four weeks after removal of adenoids.

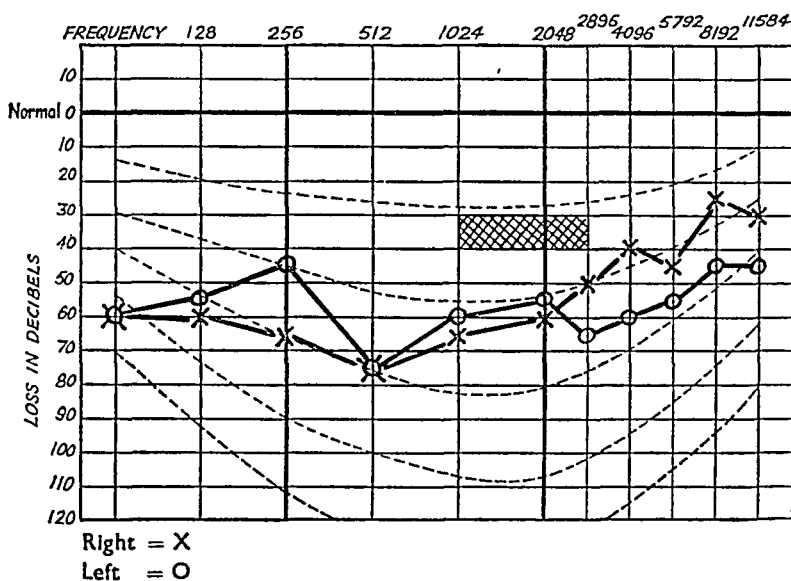


FIG. 3.

L.H., aged six. Perceptive deafness.

Otosclerosis in Childhood

adenoid infection, the nasopharynx must be examined under an anæsthetic

Perceptive deafness Otosclerosis is seldom seen in children who are deaf enough to need a special school. The tests for perceptive deafness by tuning forks and the valve amplifier hearing aid should make the differential diagnosis clear, although in most cases altered speech typical of an inner ear lesion will suggest the true cause of the deafness.

Below is the audiograph of a child of six who had been watched for some time, as otosclerosis was thought to be a possibility (Fig. 3)

She was referred to Mr. Terence Cawthorne, who kindly examined her, and considered that the deafness was of an inner ear type. A letter from the child's mother to say that she had suffered from rubella in the early months of pregnancy confirmed this diagnosis.

Treatment

Our cases have been treated by fenestration, and the hearing has improved in each case, although it is too early to say whether this improvement will last.

The difficult decision about fenestration must be taken by the parents and the otologist, and our advice in each case was for operation. An adult must make his own decision about fenestration, after learning the facts, but a child has so little to lose that operation is justifiable if there is a chance of success. The most formidable obstacle in an adult, namely disappointment, does not arise, because it is not possible to explain the operation to a child, however difficult may be the decision for his parents.

However, if operation is not undertaken, the child must be watched at school, and referred to a class for the deaf if necessary.

The importance of learning to lipread should be impressed on the parents whether fenestration is contemplated or not.

CASE HISTORIES

J.C., a girl of 11, was referred to Mr. J. P. Monkhouse at the Middlesex Hospital on April 3rd, 1947, with a history of deafness in the left ear noticed after a rocket explosion two years before. There was no family history of deafness, and no history of earache or otorrhœa.

The child was obviously deaf to ordinary conversation.

Both drums were indrawn. The left drum showed some thinning posteriorly.

The quiet conversational voice was heard at 6 inches only from either ear, the normal being 20 feet. The Rinne test with the 256 cycle tuning fork was negative on both sides, and bone conduction with the same fork was normal.

The throat was normal, but there was mucus in both nostrils. The post nasal space was not seen. X ray of the sinuses was normal.

On April 21st she was admitted for removal of tonsils and adenoids and inflation of the Eustachian tubes. There was no improvement in hearing afterwards, but it was noted that she heard 80 per cent. of speech at a normal

William McKenzie

distance with a valve amplifier hearing aid. She was referred to Mr. Terence Cawthorne at the National Hospital for Nervous Diseases, and he considered that the deafness was of a pure conductive type, and that the child was suitable for fenestration.

On March 3rd, 1948, Mr. J. P. Monkhouse explored the left ear and found the stapes fixed. The fenestration operation was completed and she was discharged from hospital three weeks later. The fistula sign was positive at

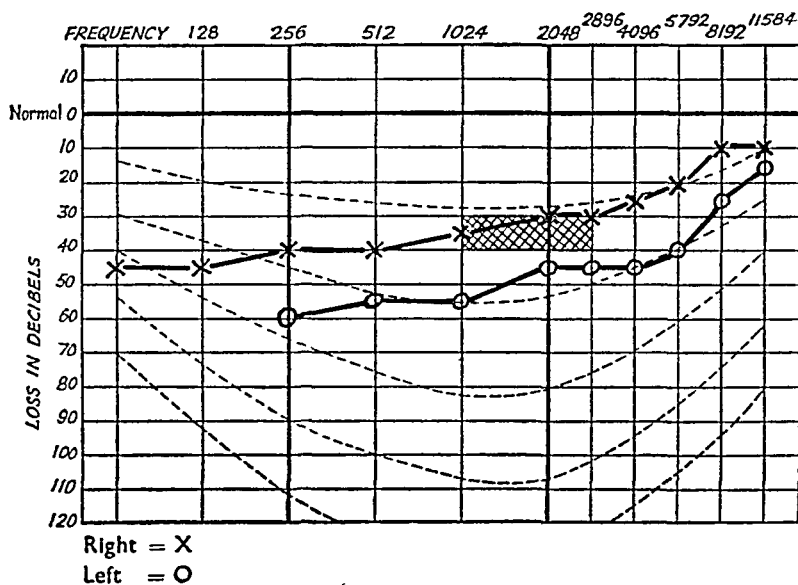


FIG. 4.

J.C., before operation (left and right ear).

the first dressing. The audiographs below show the hearing by air conduction before operation and three months after operation. The mastoid cavity when seen on July 1st, was still discharging slightly.

A.T., aged 11, was brought to Mr. C. P. Wilson's clinic at the Middlesex Hospital on September 24th, 1946, with the complaint of deafness which had been noticed since the age of 7, and which had been worse for eleven months. She had a history of otorrhœa in both ears six months before, which had lasted for a fortnight.

The tonsils and adenoids had been removed elsewhere in July, 1946, but this had not improved her. The child was obviously deaf, although her speech was normal, and both eardrums were indrawn. The quiet voice was heard at a distance of one foot on each side (normal 20 feet). The Rinne test to the 256 cycle fork was equivocal on both sides. Absolute bone conduction for 256 cycles was normal. All tuning fork tests were difficult in this child, but she heard the 256 cycle fork quite well in the centre of the forehead.

Otosclerosis in Childhood

The postnasal space contained adenoid remnants, but the X-ray of sinuses was normal. On October 1st, 1946, she was admitted for removal of adenoids, but this did not improve her.

On August 8th, 1947, she was referred to Mr. Terence Cawthorne at the National Hospital, Queen Square, who kindly reported that he could find no

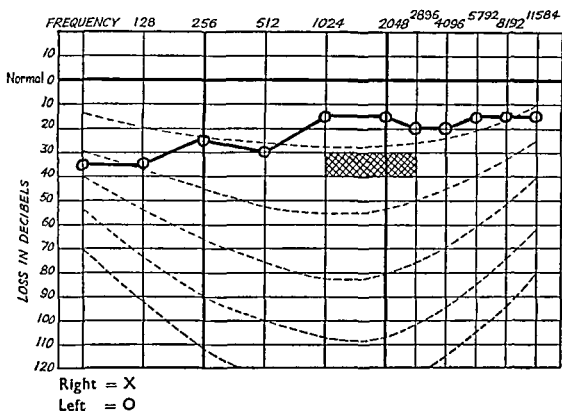


FIG 5
J C, 3 months after operation (left ear only)

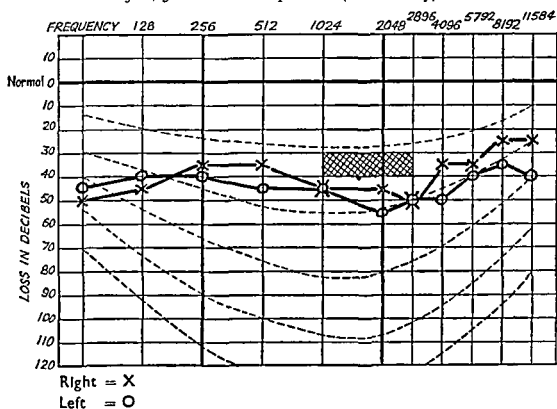


FIG 6
Audiograph of A T, aged 11 years

William McKenzie

The objection to this account and explanation may be that the diagnosis of otosclerosis is still uncertain in these cases, as there is no histological proof.

However, a conductive deafness which is progressive, and for which no other cause can be found, is probably otosclerosis, and if the middle ear is normal when seen during the fenestration operation, and the stapes feels fixed when touched with a probe, no other diagnosis can be made.

Improvement after fenestration may perhaps be considered a confirmation of the diagnosis, but our experience has not been large enough to know what effect fenestration has on other forms of deafness besides otosclerosis.

I must thank Mr. C. P. Wilson and Mr. J. P. Monkhouse for allowing me to record these cases, which were under their care.

1. The case histories of three children with otosclerosis are recorded.
2. Fenestration has improved the hearing in each case, although it is too early to say whether this is permanent.
3. The difficulties of diagnosis are discussed.

REFERENCE

- ¹ GUILD, June, 1944, *Annals of Otology*, p. 246.

OBSERVATIONS UPON THE LOUDNESS RECRUITMENT PHENOMENON, WITH ESPECIAL REFERENCE TO THE DIFFERENTIAL DIAGNOSIS OF DISORDERS OF THE INTERNAL EAR AND VIIIth NERVE

By M R DIX C S HALLPIKE AND J D HOOD (London)*

(From the Otological Research Unit Medical Research Council The National Hospital Queen Square, London)

Introduction—The Loudness Recruitment (L R) phenomenon was first described in 1936 by E P Fowler of New York (1936), and its occurrence in certain varieties of nerve deafness has since been abundantly confirmed (Steinberg and Gardner, 1937, Huizing, 1942, de Brune Altes, 1946)

The phenomenon can be demonstrated most readily when the deafness is limited to one ear, and the nature of the phenomenon itself can perhaps be best appreciated from the following brief description of the simple test procedure needed for its investigation in cases of this kind

Fig 1 shows the test procedure being applied

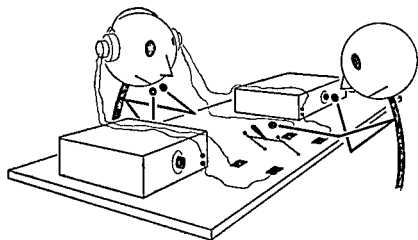


FIG 1

The subject wears a pair of telephone receivers, each supplied by a separate pure-tone audiometer, or preferably by a single audiometer with arrangements for independent adjustment of the intensity in the two

* Read at the Section of Neurology Royal Society of Medicine

M. R. Dix, C. S. Hallpike, J. D. Hood

receivers. The frequency of the sound stimulus is the same in each receiver, and the tester switches it alternately from right to left.

The audiograms of two typical cases of unilateral deafness are shown in Fig. 2.

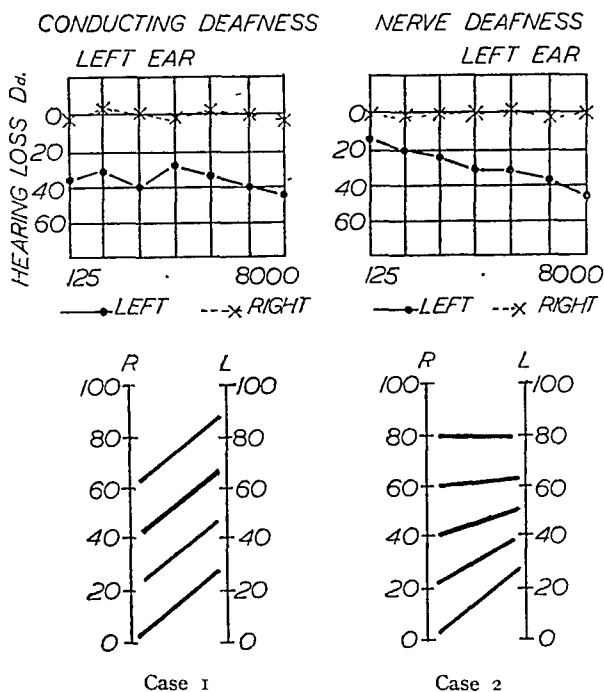


FIG. 2.—Loudness balance diagrams
Frequency 1,000 C.P.S

In Case 1 the deafness is due to a lesion of the conducting mechanism of the left middle ear, and in Case 2 to Menière's disease affecting the left labyrinth.

The purpose of the test is to ascertain and mark upon the two ladder diagrams two series of intensity levels, one for the right ear and one for the left, each intensity level for the right ear being connected across the diagram with a level for the left ear, found by experiment to give a sensation of equal loudness. In each case the test frequency selected is 1,000 cycles, at which point the audiogram shows a threshold shift for the affected ear of 30 db. The test starts with a stimulus of threshold intensity at the right ear; the balancing intensity for the left ear will, of course, be 30 db. higher. Successive stimuli, rising in intensity in steps of 20 db., are then applied to the right ear and for each level the balancing intensity for the left ear is established by trial, the comparison being made by switching the stimulus backwards and forwards between the two ears. The result obtained in Case 1 indicates that the loss of sensitivity

The Loudness Recruitment Phenomenon

or deafness of the affected ear, 30 db at threshold, remains constant at 30 db throughout the entire intensity range

This finding is an unvarying one in conducting deafness and is explicable on the straightforward assumption that the obstruction caused by the middle-ear disease to the sound waves on their way to the inner ear introduces an attenuation factor, in this case 30 db, which is constant at all intensities

A very different result is obtained in Case 2. The audiogram is substantially the same as in Case 1, with a threshold shift at 1,000 cycles of 30 db. The balancing points at threshold are identical with those of Case 1, with a 30 db displacement upwards for the left ear. On ascending the intensity scale, however, it is found that the sensitivity loss or deafness of the left ear, 30 db at threshold, becomes progressively less, until at 80 db equal intensities at the two ears evoke equal loudness responses. *In other words, the deafness of the affected ear present at threshold disappears at higher intensities, and this in its simplest terms constitutes the phenomenon of Loudness Recruitment*

A more conventional form for the graphic representation of these results is that given in Fig 3

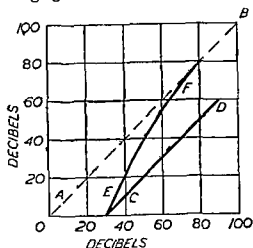


FIG 3

Sound intensities in decibels above the normal threshold are plotted on the vertical axis for the unaffected ear, and on the horizontal axis for the deaf ear. Equal loudness levels for the two ears are plotted on these charts as a series of points and the line AB passing through the origin connects the points which would be thus obtained in a normal individual.

CD is the corresponding line obtained in Case 1. Here the sensitivity loss at threshold of the deaf ear is represented by the displacement of the point C along the base line to the right of the origin. This sensitivity loss remains constant at higher intensities, and the line CD thus lies parallel to AB.

EF is the corresponding line obtained in Case 2. As in Case 1 the same sensitivity loss at threshold is represented by the same displacement of the point E to the right of the origin. At high intensities however,

this sensitivity loss is progressively eliminated, and the line EF approaches and finally coincides with the line AB.

There is general agreement by all who have since investigated the L.R. phenomenon that it is absent in deafness due to uncomplicated middle-ear disease, so-called conductive deafness.

On the other hand, it has frequently been demonstrated in a wide variety of disorders of the internal ear and cochlear nerve, including Menière's disease, which are collectively described as "nerve deafness", and it has come, therefore, to be regarded in a somewhat uncertain manner as a valuable indication of "nerve deafness" using the term in its widest sense.

The theoretical basis of the L.R. phenomenon has been discussed by Lorente de Nó and by Fowler (1939). Both adopt an explanation based upon certain general principles of neurophysiology and upon certain details of the finer structure of the cochlear neurones described earlier by the former. According to this explanation—a somewhat complex one—the occurrence of the phenomenon might be expected as a natural consequence of any pathological process involving a reduction in numbers of the neural elements, either of Corti's organ or of the cochlear nerve, and the matter is put by Lorente de Nó (1937) in the following terms:

"If a number of hair cells in the ear or a number of fibres in the cochlear nerve is missing, the tones will appear to be weaker in intensity when near threshold stimuli are used; but if the intensity of the tone is increased, the more strongly activated hair cells or cochlear fibres will be sufficient to saturate, i.e., to excite with the limiting intensity the cochlear fibre or the cells of the cochlear nuclei, so that the cerebral cortex will receive the same number of impulses per second from both ears and will perceive the tone delivered to the diseased ear as strongly as the tone delivered to the normal or less affected ear.

"Thus, it may be said that Fowler's phenomenon is an immediate consequence of the anatomy and physiology of the nervous system, and that, in fact, it must be pathognomonic of neural deafness."

The phenomenon of recruitment, or the variable type of deafness as they call it, is also discussed by Stevens and Davis (1938). These authors, too, accept the view that the phenomenon is attributable to "a deficiency in the total number of neural elements which normally contribute to give a tone loudness".

It must be said of the explanation that its implications are not devoid of obscurity. Moreover, in some of the cases in which the phenomenon has been found to occur, we seriously lack secure information on the nature of the pathological process. It has, therefore, been clear for some time that the confirmation of de Nó's explanation, and indeed any further developments of theory, must await a great deal of additional factual information. De Bruine-Altes (1946), in her recent monograph,

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has stressed very pertinently the particular need for further studies in which the results of L R phenomenon tests are more closely correlated with more exact information upon the underlying anatomical changes in the cochlea and cochlear neural pathways

In the present study, therefore, we have endeavoured to throw more light upon the mechanism of the L R phenomenon by means of a detailed clinical study, including full investigation of the phenomenon in a number of patients referred to us by our colleagues at Queen Square and elsewhere suffering from two different and clearly defined varieties of hearing disorder, of which our knowledge both of the clinical features and morbid anatomy can now be regarded as considerable. The two disorders are Meniere's disease and degeneration of the VIIIth nerve due to neuro-fibroma of the nerve and to other space-occupying lesions of the cerebello-pontine angle

It was considered that the choice of these two disorders was likely to be particularly illuminating since in the one, Meniere's disease, the primary lesion we now know to affect the endolymph system of the cochlea with its contained cochlear end-organs, while in the other, the primary lesion is of the cochlear nerve fibres within the internal auditory meatus

Some further details may be given at this point of these anatomical changes and their correlated symptomatology

Meniere's Disease—Fig 4 shows the histological condition of the cochleae in a case of Meniere's disease

The subject, a man of 46, had suffered for four years from paroxysmal attacks of vertigo with deafness and tinnitus of the right ear. Otological examination revealed a severe perceptive deafness on the right side, and a defect in the right caloric responses. The tympanic membranes were normal and there were no other abnormalities in the central nervous system. The patient died of acute lymphatic leukaemia.

Fig 4A shows the cochlea of the unaffected ear (left) and Fig 4B the cochlea of the affected ear (right)

In Fig 4A, the normal position of Reissner's membrane will be noted (arrows). Corti's organ appears normal.

The apparent disappearance of Reissner's membrane in Fig 4B has been brought about by the maximal distension of the scala media, which has thrust the membrane back upon the bony wall of the scala vestibuli and caused its herniation through the helicotrema. Arrows indicate the new position of the membrane. It should be noted, however, that the cells of the spiral ganglion appear quite normal in number and structure. Further, there is no apparent reduction in number of the cochlear nerve fibres in the modiolus, or in the osseous spiral lamina.

Figs 5A and B show the organ of Corti of the two ears. That of the left ear, Fig 5A, is fairly well preserved, and presents a normal appearance

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The cell outlines are well demarcated, and the cell nuclei are clearly differentiated.

It should be noted, however, that as usual in preparations of the human cochlea the technical difficulties of fixation make it impossible to discern any details of the hair cells.

In the affected ear, Fig. 5B, marked changes are to be seen in Corti's organ. The cell mass is compressed, the cell outlines obscured and the staining differentiation between nuclei and cytoplasm virtually extinguished.

This type of pathological change in the cochlea was first described by Hallpike and Cairns (1938) in two clinically characteristic cases of Menière's disease. Since then, histological studies have been possible in three further cases, in one instance in collaboration with A. J. Wright (1940), and in a second with T. E. Cawthorne (1947).

The findings in a third case have not yet been published.

In addition to these, a number of other histological examinations have been carried out elsewhere (Rollin, 1940; Lindsay, 1942; Altmann and Fowler, 1943) in a number of subjects presenting the characteristic clinical features of Menière's disease.

Whilst in all of these the presence of an endolymphatic dilatation has been established, reports have varied on the condition of Corti's organ. In two of our own series it has appeared normal, and this has also been the finding in the majority of cases reported upon elsewhere. In no less than 3 of our 5 cases, however, Corti's organ has presented abnormalities of the type described. These abnormalities are so striking in character that it would appear inevitable that they should be regarded as being distinctive of Menière's disease in certain of its phases. That they are found sometimes and not always only means, as we see it, that they represent a transient and reversible reaction on the part of the hair cells to the chemico-physical disturbance which goes with the gross distension of the endolymph system. It seems quite reasonable that this disturbance should be phasic in character, so matching the clinical course of the disease, and it is natural, too, that the morphological changes in the hair cells should vary at the same time. It follows, that whether these changes are revealed in any given case or not must be largely a matter of chance, depending upon the phase of the disease at the time of death.

Although these morphological changes may be largely reversible, and may in fact appear to be absent at death, it does not follow that a corresponding reversal need be expected of the functional loss, and, indeed, the fact that the deafness in Menière's disease persists between its active phases can only be taken to mean that while the disorder of structure *is* apparently reversible, the disorder of function *is not*. The statement that the structural disorder in Menière's disease is *apparently*



FIG 4A — 75

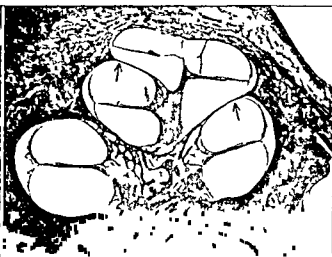


FIG 4B — 75

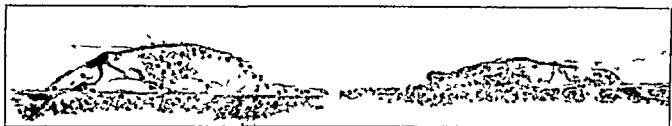


FIG 5A — $\times 200$

FIG 5B — $\times 200$

(Figs 4 and 5 are reproduced by permission of the Editor *The Annals of Otolaryngology and Laryngology*.)

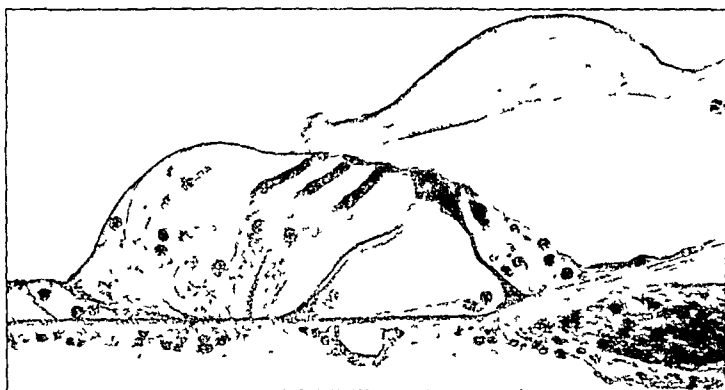


FIG 6.— $\times 310$

(Reproduced from Schäfer's 'Essentials of Histology' by permission of Messrs Longmans, Green & Co.)



FIG 7 — 11

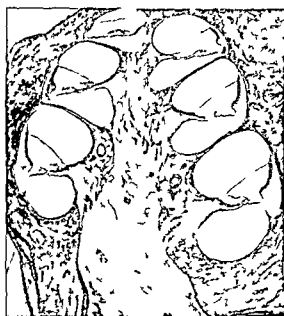


FIG 8 — 9

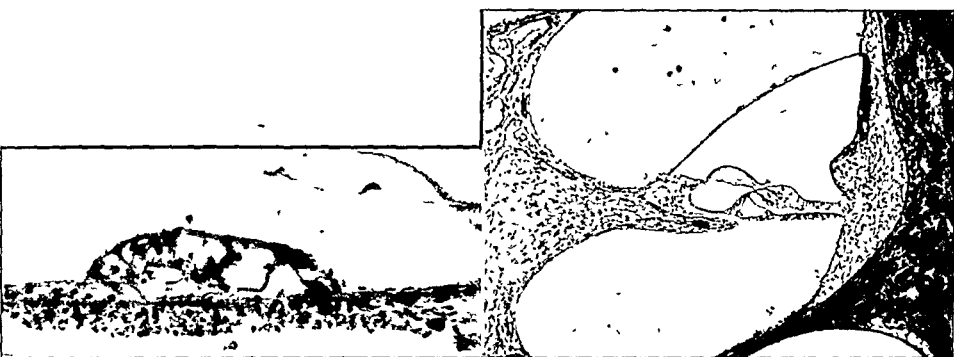


FIG. 9A.— $\times 200$ Neurofibroma of the human
VIIIth nerve

FIG. 9B.— $\times 50$. Degeneration following intra-
cranial section of the VIIIth nerve of the cat.

The Loudness Recruitment Phenomenon

reversible requires some amplification in view of the well known technical difficulties which beset the histological study of the human organ of Corti. Its post-mortem disintegration is rapid, and fixation difficult, and the resulting histological picture is, therefore, always an imperfect representation of the original.

This point will be made clearer from an examination of Fig 6 and its comparison with Fig 5A. Fig 6 shows the organ of Corti in a cat, well fixed by an *intra-vitam* injection technique. Every detail of the hair cells and their associated membranes is well shown.

In human material, however, of which Fig 5A is a good representative sample, nothing like this degree of preservation is possible. The hair cells are seldom well defined, and such features as the nerve fibres crossing the tunnel of Corti are never to be seen. This means, inevitably, that changes in the human hair cells, morphologically slight but functionally vital, which are likely to be responsible for the deafness during the negative phases of Meniere's disease, will never be demonstrable by histological means.

For this reason, although no definite abnormalities can be recognized in Corti's organ in some cases of Meniere's disease, we feel it to be very likely that such changes *are* present and obscured only by the limitations of histological technique.

To sum up the structural changes found in Meniere's disease, we can say that these are limited to Corti's organ, but the nerve fibres and cells of the spiral ganglion are normal.

Degeneration of the VIIIth nerve due to neurofibroma, etc — Interruption of the cochlear nerve fibres central to the spiral ganglion, whether caused by pressure from a tumour or by surgical section, leads, in contravention of the Wallerian law, to degeneration of the nerve fibres and ganglion cells peripheral to the point of interruption (Witmaack, 1911, Kaida, 1931, Hallpike and Rawdon-Smith, 1934).

Fig 7 shows a horizontal section through the cochlea of a patient with a high degree of deafness and a complete loss of the caloric responses resulting from a neurofibroma of the VIIIth nerve. The tumour is seen filling the meatus, and the fibres of the VIIIth nerve are lost to view. The main peripheral effect of this tumour is a gross reduction in the number of nerve fibres themselves and of the cells of the spiral ganglion.

Indeed, very few cells of the ganglion remain while the nerve canal of the osseous spiral lamina is virtually empty.

Corti's organ, however, is substantially normal and this is characteristically the case unless the tumour has involved the cochlear blood supply. These cochlear changes in VIIIth nerve tumours closely resemble in their essentials those which follow an operative section of any mammalian VIIIth nerve. Fig 8 shows the cochlea of a cat twelve weeks after an intracranial section of the VIIIth nerve. It shows again

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were able to find the cases, we owe to the good offices of a number of our colleagues both at Queen Square and elsewhere who have kindly referred their cases to us, and to whom we are greatly indebted.

In the majority of these 20 cases, tuning fork tests showed the typical findings of nerve deafness, reduced bone conduction with a positive Rinne. Bone conduction was, in fact, reduced in all, but in a few the Rinne test was definitely negative in spite of careful masking of the opposite ear.

The results of the loudness balance tests in 14 cases of this group were constant in showing a complete absence of recruitment.

Fig. 11 shows the test results in 3 characteristic cases, together with

VIIIth NERVE DEGENERATION

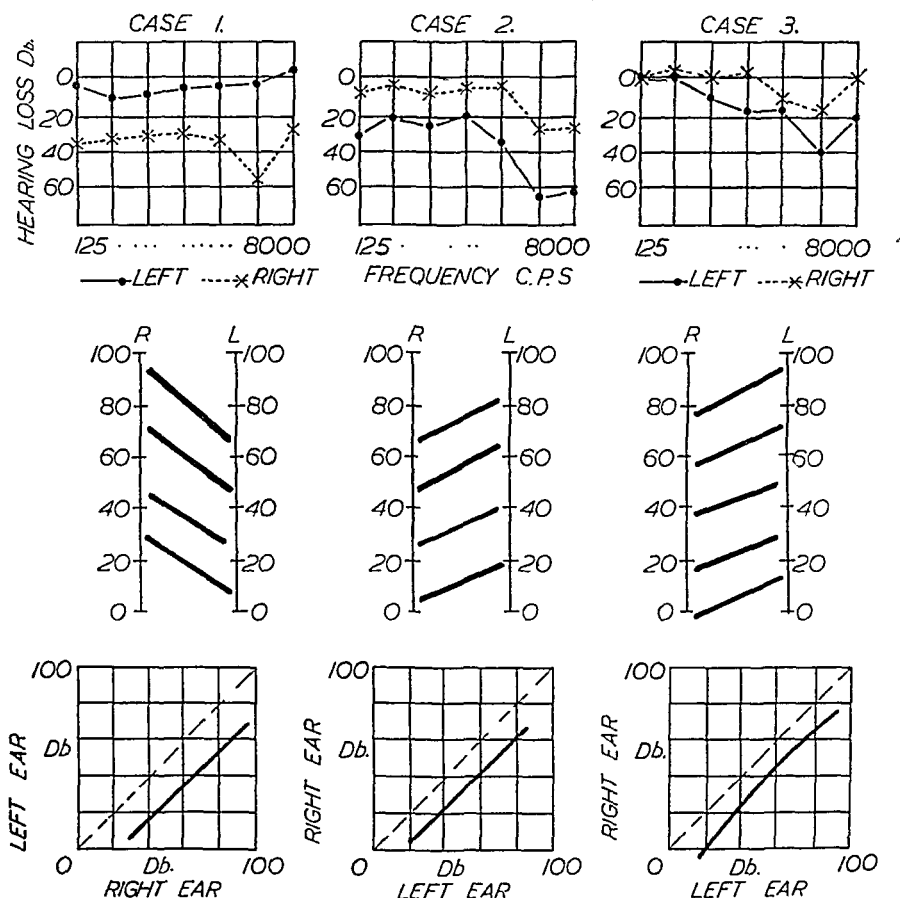
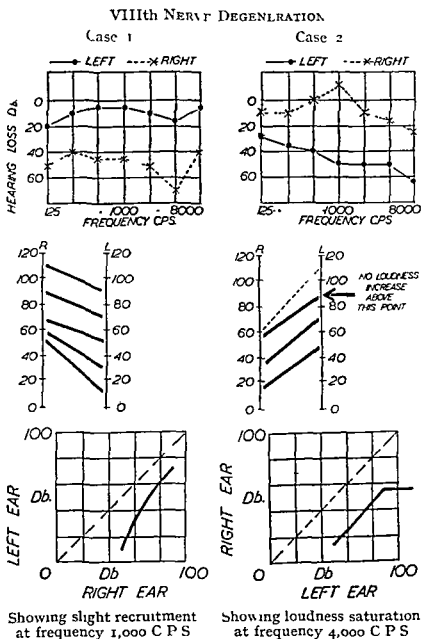


FIG. 11.—Loudness balance diagrams. Frequency 1,000 C.P.S.

their audiograms. It will be seen that in all 3 the sensitivity loss of the affected ear at threshold is maintained at all intensity levels. In the remaining 6 cases of this group a slight amount of recruitment was present.

The Loudness Recruitment Phenomenon

In some of these there was found a fixed upper loudness limit in the affected ear. That is to say, loudness appeared to increase in the affected ear up to a certain intensity level, and thereafter to increase no more. This phenomenon is shown in the second case of Fig. 12. Tests at other frequencies than 1,000 cycles yielded comparable results.



Summary of Experimental Findings

Loudness recruitment was present and complete in all of 30 cases of Menière's disease, a primary affection of Corti's organ. In 20 cases of degeneration of the VIIIth nerve, due to pressure or infiltration by tumours, Loudness Recruitment was completely absent in 14. In the remaining 6 cases slight recruitment was present.

It would appear, therefore, that in this condition, an example par excellence of nerve deafness, Loudness Recruitment hitherto described as being

uniquely distinctive of nerve deafness is characteristically not present at all. Instead, we have a type of response which is identical with that found in middle-ear deafness.

Discussion

From the viewpoint of practical oto-neurology, the experimental results described make it clear that in the loudness balance test we have at our disposal a test procedure which should prove of great value in making clear the difficult and important distinction between end-organ deafness and nerve-fibre deafness. It seems likely, too, that the findings will prove to have a bearing upon a number of problems of auditory theory. The finding that the recruitment phenomenon is an unvarying occurrence in Menière's disease, a disorder of the end-organ of hearing, appears to be related in an interesting way to the recent experimental work of Pumphrey and Gold (1948). According to Gold's theory, based upon this work, the microphonic potentials of the cochlea arise somewhere in Corti's organ and play a vital part in determining both its sensitivity and frequency selectivity. We should, therefore, certainly expect that a disorder of this microphonic mechanism, i.e., Corti's organ, would lead to deafness and to certain disorders of pitch sense, i.e., paracusis dysharmonica, well known to be characteristic of Menière's disease. It is pertinent to recall that the very nature of the recruitment phenomenon corresponds very well with a type of derangement well known in certain microphones. Thus a carbon microphone in good order yields an electric response which is linear over a wide range of sound pressures. In a faulty microphone of this kind, however, the response at low sound pressures may be very defective, while approximating at high pressures to something nearer its normal value. It is clear that this variety of non-linearity in the response of a faulty microphone reproduces in essentials the characteristic of the Loudness Recruitment phenomenon, and it seems possible, therefore, that Gold's theory of the cochlear mechanism may provide us with a clearer explanation than any at present available of the occurrence of the Loudness Recruitment phenomenon in Menière's disease.

The finding that recruitment is characteristically absent in cases of VIIIth nerve tumour has been a very surprising one. Clearly it controverts decisively the theory of its neurological mechanism advanced by Lorente de Nó and Fowler. It would seem quite possible, however, to explain this finding in a different and more simple way if the following assumptions be made: first, that the nerve degeneration engendered by tumour pressure or infiltration is an evenly diffused one with a definite fibre survival rate; secondly, that the relationship between stimulus intensity and loudness sensation depends upon a simple type of formula

The Loudness Recruitment Phenomenon

governing the numerical increase of active cochlear nerve fibres which accompanies each ascending step of the loudness scale

Such a formula may be outlined as follows

LOUDNESS / SOUND INTENSITY

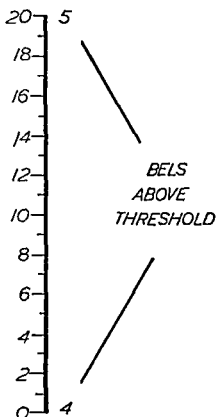


FIG 13 —Distinguishable loudness steps (each step corresponds to an intensity increase of about 13%)

The intensity range on the scale shown in Fig 13 lies between four and five bels above the threshold of hearing for a tone of 1,000 cycles, that is to say, it covers the middle range of audible intensity for this frequency, and the total intensity change of 1 bel between the top and bottom of the scale is a tenfold one. Between these points there are twenty just distinguishable increments of loudness, each corresponding to an intensity increment of about 13 per cent, this being the so-called Weber fraction, and according to the data of Shower and Biddulph (1931) the value of this fraction for frequencies between 1,000 and 4,000 cycles approximates very closely to the value given, i.e., 13 per cent for a great part of the loudness scale.

Concerning the manner in which the steps on this loudness scale are related to the number of active nerve fibres, no precise quantitative details are known. We have, however, available a variety of well-known data derived from the electro-physiological recording of cochlear action potentials and from experiments on masking and auditory fatigue, which all indicate that as stimulus intensity is increased there occurs a spatial spread within the cochlea, with progressive activation of additional nerve fibres.

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It is suggested that our present experimental finding, i.e., that Loudness Recruitment is absent in diffuse degeneration of the VIIIth nerve, would be adequately explained upon the following simple hypothesis: that each step on the loudness scale shown in Fig. 13 corresponds to a definite fractional increase in the number of activated cochlear nerve fibres. The manner in which this hypothesis might be applied to the working of the normal and degenerate cochlear nerves is shown schematically in Fig. 14.

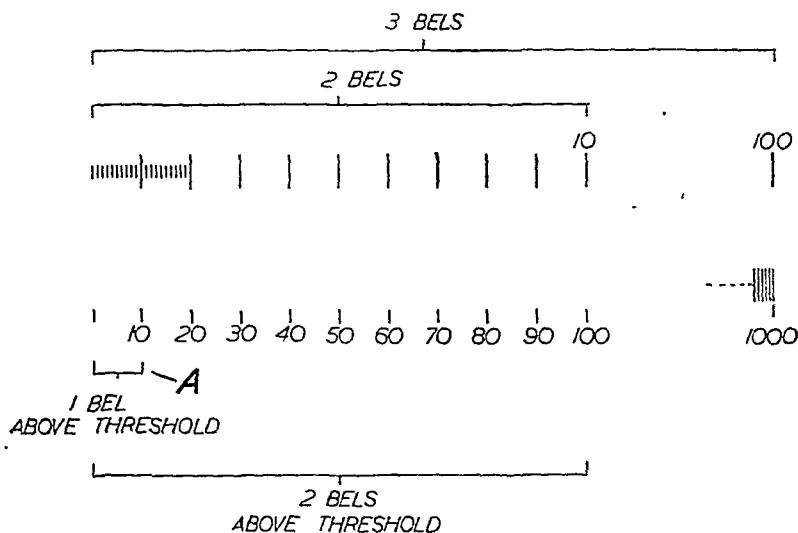


FIG. 14.

This represents the fibres of two cochlear nerves arranged in linear fashion as they lie in the osseous spiral lamina of the cochlea.

The lower set of fibres is that of a normal nerve, while the upper set is that of a degenerate nerve. The degeneration is diffuse, and the long strokes indicate the surviving fibres. The survival rate is one in ten. The small bracket "A" is taken to indicate the number of fibres stimulated by a sound stimulus of intensity 1 bel above threshold. The number of fibres is conveniently taken as ten. This stimulus exceeds by tenfold the threshold intensity. Correspondingly, stimulus intensities of two and three bels exceed it by one hundred- and one thousand-fold. Now, it is supposed that such changes of stimulus intensity involve corresponding changes in the number of active nerve fibres. This means, in the case of the normal nerve, that the 2 bel stimulus will activate 100 fibres and the 3 bel stimulus 1,000 fibres.

It will be noted that the loudness sensation elicited in the normal nerve by the 1 bel stimulus arises from 10 fibres, and to match this

The Loudness Recruitment Phenomenon

sensation in the degenerate nerve, 10 active fibres will also be required. It is clear that with a fibre survival rate of one in ten, a 2 bel stimulus will be required to bring these into action. In other words, a tenfold intensity increment, 1 bel, is required to compensate for this particular degree of nerve degeneration.

With a stimulus intensity of 2 bels, it will be seen that 100 fibres are activated in the normal nerve. To activate the same number in the degenerate nerve, we require again a tenfold increase of stimulus intensity, i.e., a 3 bel stimulus, and it follows that the same rule will apply as we go further up the intensity scale. In other words, given a constant fibre survival rate in the degenerate nerve, this would be compensated by a constant fractional increment of stimulus intensity at all points of the intensity scale.

This argument, therefore, leads us to expect that the sensitivity loss, or deafness of the affected ear in a case of diffuse degeneration of the VIIIth nerve, would be constant throughout the intensity range. In fact, the Loudness Recruitment phenomenon would be absent in accordance with our own experimental findings.

It is necessary to add two amendments to this general statement of theory.

It is unlikely to apply at low intensity levels near threshold, where the sensitivity of the ear to small intensity differences is changing rapidly. At high levels too, it would seem inevitable that a saturation point would be reached very soon in the case of the degenerate nerve, above which no further increase of loudness perception would be obtainable.

This latter point is in good agreement with the finding in some of our cases of a fixed upper limit of loudness in the affected ear.

The highly schematic character of our hypothesis need not be stressed. It would indeed appear evident that loudness grading depends upon a grading not only of fibre numbers but of discharge frequency in the fibres themselves, the resultant being a grading of the total number of nerve impulses reaching the cochlear centres per unit time. While this may be the case, it is doubtful whether it would seriously affect the general validity of our hypothesis.

Thus, while a certain degree of nerve degeneration may lead to a definite fractional decrease in the number of cochlear fibres activated by a sound stimulus of given intensity, it is likely, also, to lead to a definite fractional decrease in the discharge frequency of these surviving fibres, and the combination of these two effects will result in a fixed fractional decrease in the total number of action potentials reaching the cochlear centres per unit time.

This decrease will be compensated and loudness loss restored in the manner of our experimental findings by a fixed fractional increase of stimulus intensity over a wide range of the intensity scale.

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Summary

Loudness balance tests were carried out in :

- (a) 30 cases of unilateral deafness due to Menière's disease.
- (b) 20 cases of degeneration of the VIIIth nerve, due to neurofibroma of the VIIIth nerve and other varieties of space-occupying lesions of the cerebello-pontine angle.

Results.—Loudness Recruitment was found to be present and complete in all 30 cases of Menière's disease.

Loudness Recruitment was found to be absent in 14 of the 20 cases of VIIIth nerve degeneration. In the remaining 6 cases it was present but incomplete.

Loudness Recruitment was thus shown to be characteristically present in a disorder of the end-organ of hearing and to be characteristically absent in a disorder of the cochlear nerve fibres.

This latter finding sharply controverts existing views upon the neurological mechanism of recruitment. The practical and theoretical significance of the experimental results is discussed. New hypotheses are advanced in explanation of these results and are based upon recent experimental work on the physiology of hearing and upon the known pathology of the cochlea and VIIIth nerve.

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ON THE PHYLOGENY OF THE MAMMALIAN AUDITORY OSSICLES*

A TUMARKIN (Liverpool)

IN a recent publication¹, Gerrie has outlined what may be called the orthodox conception of the evolution of the mammalian auditory ossicles. He states that "Although one or two minor points still require clarification, the main course pursued may be now regarded as finally settled"

In November, 1947, before the Otological Section of the Royal Society of Medicine I presented an alternative theory which differs from the orthodox theory in almost every fundamental feature. I have listed a few factual differences below. These and many more which could be quoted indicate a totally different approach to the problem.

ORTHODOX THEORY	WRITER'S THEORY
The early amphibia possessed tympanic membranes	They did not
The early stem reptiles (Cotylosaurs) possessed tympanic membranes	They did not
The early pre mammalian reptiles (Pelycosaurs) possessed tympanic membranes	They did not
The later pre mammalian reptiles (Therapsids) possessed tympanic membranes	They did not
The Frog's tympanic membrane is homologous with the reptiles	It is not
The mammalian tympanic membrane has evolved by direct extension of a reptilian tympanic membrane	It has not

It is not my intention to discuss the relative merits of the two theories in this present article. That must be delayed until the writer's theory has been published in full. It is my purpose in this short note to draw attention to certain errors of fact in Dr Gerrie's article—not out of any desire to score debating points—but because the discussion will throw light on what I believe to be the basic weakness of the orthodox theory.

The latter is based almost exclusively on evidence drawn from palæontology and from ontogeny.

Practically no regard is paid to the functional aspects of the problem. Changes are postulated during the course of evolution without any real

* This article and the following one are to some extent complementary —Ed

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consideration of their functional implications. To take a case in point, it is believed that a tympanic membrane was present in the earliest amphibia. The evidence for this belief is purely palæontological—that is to say the fossils in question show a notch between tabular and squamosal. It is true that in some cases the columella (i.e., the stapes) appears to point towards this so-called otic notch but in actual fact the main attachment of the columella was to the quadrate bone.

Thus the evidence for a tympanic membrane in these early amphibia is of the most flimsy nature and completely ignores the functional aspect to which I have drawn attention elsewhere.

The fact is that these animals did not possess an oval window. Now on physical grounds it can be shown that in the absence of an oval window a tympanic membrane would be completely useless. In the writer's opinion the tympanic membrane was a very late development in the evolution of the middle ear. Evidence could be adduced from many sources to support that thesis but that would lead us far afield. I merely quote this example to show the danger of concentrating entirely on palæontological and embryological evidence.

This pre-occupation with the tympanic membrane is indeed a fundamental weakness. It leads to an almost complete disregard of all other modes of hearing. I have described in terrestrial vertebrates at least six different middle-ear mechanisms—only two of which boasted a tympanic membrane. It is true that the other four are comparatively crude structures—nevertheless biologically they must be regarded in exactly the same way as the two classical mechanisms. All six represent different solutions of the mechanical problem which confronted the primitive amphibia when first they floundered on to dry land—the problem of picking up acoustic vibrations.

Orthodox theory concerns itself only with two mechanisms, each boasting a tympanic membrane, i.e. the reptilian type subserved by a single ossicle (usually called the columella) and the familiar triple ossicle mechanism of the mammal. All other mechanisms are either ignored or dismissed as degenerate.

In the writer's opinion the phylogeny of the mammalian ossicles cannot be discussed as an independent problem. It is essential to take account of all the other auditory mechanisms. Only thus is it possible to avoid the many errors which are inherent in the orthodox theory.

Dr. Gerrie for instance states that "A tympanic cavity is exhibited by all living reptiles with the exception of snakes." That is far from correct as will be shown by a simple enumeration of the many other types which also do not possess a tympanic membrane.

The Amphisbænids use the floor of the bucco pharynx as a means of picking up vibrations. A tiny conical stapes is connected to a long stylus which runs in the floor of the mouth as far as the submaxillary

Phylogeny of the Mammalian Auditory Ossicles

gland This stylus is derived from the hyoid I call this vestibulo-hyoid hearing because the stapes stretches from the vestibule to the hyoid There is no tympanic membrane and no middle ear cavity

In snakes the stapes runs to the quadrate The reptilian jaw hinges on the articulo quadrate joint and therefore snakes hear by picking up vibrations with their lower jaws This (VQ) vestibulo-quadrate system is a crude bone conducting mechanism—but it is *not* confined entirely to snakes Many Agamid and Iguanid lizards and also the Chameleons use vestibulo quadrate hearing The extinct cotylosaurs, pelycosaurs and therapsids also used this mechanism Lastly, Sphenodon—the sole surviving member of the Rhynchocephalia has no true tympanic cavity either

Dr Gerrie goes on to say that the amphibia are in many cases so degenerate that only the terrestrial anura have a tympanic cavity The implication is that the other amphibia, i.e., the urodeles and apoda only possess degenerate middle ears That is far from proven Some of these animals use VQ hearing, others use what I have called vestibulo-squamosal hearing (VSq), but no one has ever demonstrated that either VQ or VSq is “degenerate” Furthermore the urodeles—in common with the anura—possess a remarkable auditory mechanism which I call vestibulo scapular (VS) This enables them to pick up vibrations from the substrate by means of the forepaw

This mechanism has nothing whatsoever to do with the hyomandibular (out of which all other auditory mechanisms are derived by *orthodox morphologists*) The vestibulo scapular auditory mechanism is an entity sui generis and no theory can be regarded as adequate which fails to recognize and explain its evolution

Lastly, Dr Gerrie makes the remarkable statement that “Fishes being dependent on underwater vibrations for sound perception do not possess, and indeed do not require a middle ear”

It is now a hundred years since Weber described the middle ear of the ostariophys² A brief account of it appears in this issue, and I have no doubt that Dr Gerrie is well aware of its existence It seems to me that the difference between us must reside in the definition of “middle ear” If—as I suspect—Dr Gerrie means a structure comprising a delicate trilaminar drumskin with an ossicular chain lying air borne in a tympanic cavity, then certainly fishes do not possess a middle ear Such a definition is, however, completely sterile

From the functional point of view a middle ear is a mechanism which enables an animal to pick up vibrations from the environment and transmit those vibrations to its inner ear The ostariophys² have in fact extremely efficient hearing due to their possession of this middle ear mechanism By contrast the non-ostariophys² are much deafer This anthropocentric pre-occupation with a tympanic membrane leads

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Dr. Gerrie to deny a middle ear to the fish and to go even further in saying that they "do not require one". I am not quite certain what is meant by that statement, but if it means that fishes would not hear better if they did possess a middle ear then manifestly it is quite wrong. There is ample evidence to prove the value of the Weberian system. The ostariophysi enjoy an auditory acuity comparable with that of the mammals. It is much superior to that of the non-ostariophysi—a superiority which is entirely attributable to their possession of a "middle ear".

To sum up

1. The orthodox theory of the evolution of the mammalian auditory ossicles is not adequate.
2. It falls into grave errors by its disregard of the functional requirements.
3. It is excessively pre-occupied with the tympanic membrane.
4. It ignores the valuable evidence to be culled from a study of many other types of middle ear—including those of the fish.
5. It labels as "degenerate" many other auditory mechanisms which are in fact entirely independent and in no way degenerate.

In due course I hope to publish an account of an alternative theory which will avoid the above errors and yet will be found to explain all the evidence on which the orthodox theory is founded.

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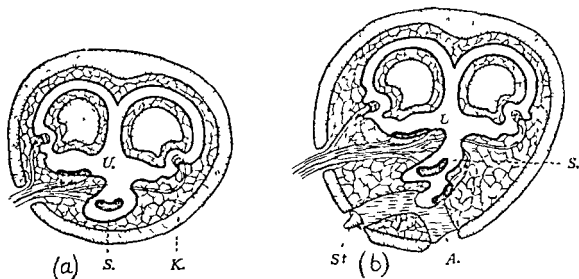
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ON THE EVOLUTION OF THE AUDITORY PERILYMPHATIC SYSTEM

A. TUMARKIN (Liverpool)

THE round window may be functionally defined as the distal extremity of the perilymphatic duct, the proximal extremity being formed by the oval window. In mammals, the perilymphatic duct (consisting of the combined scalae, tympani and vestibuli) is closely applied to the scala media. So close indeed is the association that it tends to obscure the fact that ontologically and functionally the perilymphatic system is entirely different from the endolymphatic system. The latter is essentially a specialized portion of the sacculle whereas the former develops as a loculation in the connective tissue surrounding the primitive labyrinth.

Fig. 1 shows the relations as envisaged by De Burlet.¹ He argues, quite correctly, that true hearing in the vertebrate does not occur except in the presence of a perilymphatic duct. The function of the duct is



FIGS 1A AND 1B—THE DEVELOPMENT OF THE PERILYMPHATIC DUCT

Fig 1A shows the primitive labyrinth completely enveloped in connective tissue. Fig 1B shows the modifications associated with the evolution of the auditory function. At St a soft spot appears in the bony capsule. It is partly filled by a plunger. An escape port develops at A and between them the perilymphatic duct runs. Part of the neuro epithelium of the saccule become specialized to receive the impact of the perilymphatic fluid when sound waves strike St.

S = Saccule.

U = Utricle

K = Auditory capsule

[Photograph from *Biological Reviews* 1936, Vol 11 p 225.]

quite clear. It canalizes the perilymphatic fluid on to the sensitive neuro-epithelium and it should be noted that the perilymph undergoes mass movement. The distinction between acoustic energy and the energy

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of mass movement has been discussed elsewhere² and is of fundamental importance. It may be brought out more clearly by reference to the state of affairs found in the fish.

Fishes may be divided functionally into the ostariophysi which are characterized by the possession of a true organ of hearing and the non-ostariophysi which have no such organ. It should, not, however be deduced that the non-ostariophysi are completely insensitive to sound vibrations. Consider a fish in water in the path of a sound wave. The tissues of the animal are, functionally speaking, so similiar to the surrounding water that for all practical purposes we may assume that the sound wave passes through the fish just as it does through each lamina of water. We know that each lamina of water, when attacked by the sound wave, undergoes a phase of compression followed by a phase of rarefaction and then returns to its normal condition, the wave front having passed on. Precisely the same chain of events occurs in the fish. Every particle of the fish undergoes condensation and rarefaction. It might be thought that the bones would re-act differently from the soft tissues but actually the physical differences are not large enough to invalidate the above argument. In the skin of the fish are touch receptors which are responsive to pressure and/or deformation. *Providing the sound wave is of sufficiently low frequency, it will act as a series of touches on these receptors.* Thus the fish recognizes sound by means of its skin. This function persists in all higher animals including man, and is utilized by Gault and his School³ for the education of deaf children. Remarkable claims have been made as to the efficiency of this vibro-tactile sense. They need not concern us here. It will suffice to note the existence of the function, which we label Mechanism No. 1.

Returning to the fish, we note that in the labyrinth, more precisely in the maculi of the saccule and utricle, specialized touch organs exist which have been seconded for the purpose of responding to gravity. They still possess the primitive sensitivity to pressure and so behave precisely as the touch receptors in the skin. In addition, however, they are provided with oto-conia and it is clear that in the process of vibration the massive oto-conia will tend to lag behind the movements of the supporting neuro-epithelium. The action will be something like that of the clapper of a bell. Thus it is that the undifferentiated saccule possesses the power of responding to sounds of low frequency. This is Mechanism No. 2. In a way the oto-conium might be regarded as a primitive type of middle ear mechanism, but leaving that aside there is no other structure in the non-ostariophysi which could be so considered. There is no perilymphatic duct and neither oval or round windows are necessary for these primitive mechanisms. The essential feature in both is that they respond to the sound wave as such. There is no conversion of the sound wave into any other form of energy.

Evolution of the Auditory Perilymphatic System

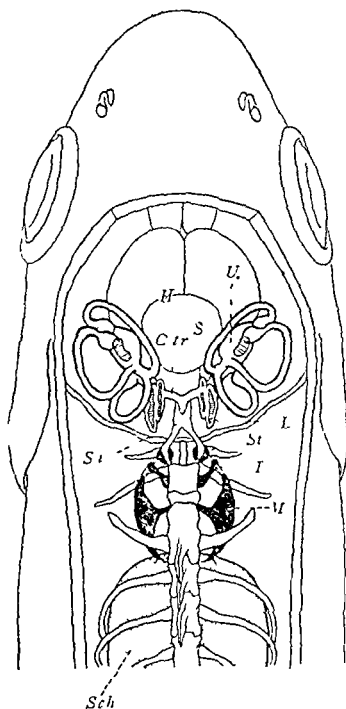


FIG 2A

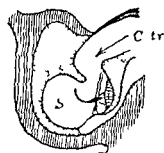


FIG 2B

FIG 2A — THE MIDDLE EAR (Weberian System) OF THE OSTARIOPHYSI

The Weberian ossicles are black (M I and St). There is no cochlea. The saccule S (and possibly the lagenella L) respond to sound waves brought to them via the perilymphatic duct Si (i.e. the sinus impar). C tr (i.e. canalis transversalis) is part of the endolymphatic system and corresponds to the scala media of the mammalian ear.

The ossicles are analogous but not homologous with the mammalian ossicles. The swim bladder is analogous but not homologous with the mammalian drumskin. The sinus impar is analogous but not homologous with the scala tympani plus vestibuli. The membranous window in the chondrocranium through which the sound waves reach Si is analogous to the oval window of the mammal.

Note that the whole labyrinth lies free in the cranial cavity. It is not enveloped in bone.

[Photograph from *Biological Review* of Cambridge Phil Soc. 1936 Vol. 11 p. 224.]

FIG 2B — THE AUDITORY END ORGAN OF THE OSTARIOPHYSI

The whole of the saccule (except the lagenella) together with its otolith has been converted into an organ of hearing. Waves in the Canalis transversus strike the specially moulded otolith and set up specific stimulation of the subjacent neuro epithelium.

[Photograph from *Biological Review* 1936 Vol. 11 p. 5.]

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Figs. 2A and 2B shows the auditory mechanism of the ostariophysi. Sch is a specialized portion of the front of the swim bladder. M is the tripus—a triangular ossicle derived from the transverse process of the adjacent vertebra. It has three processes. One is attached to Sch, another is attached to the vertebral column and the third passes forward to join the inter-calarium I. The latter articulates with the scaphium Sr which in its turn joins the claustrum which is a small flake of bone lying in a window in the auditory capsule.

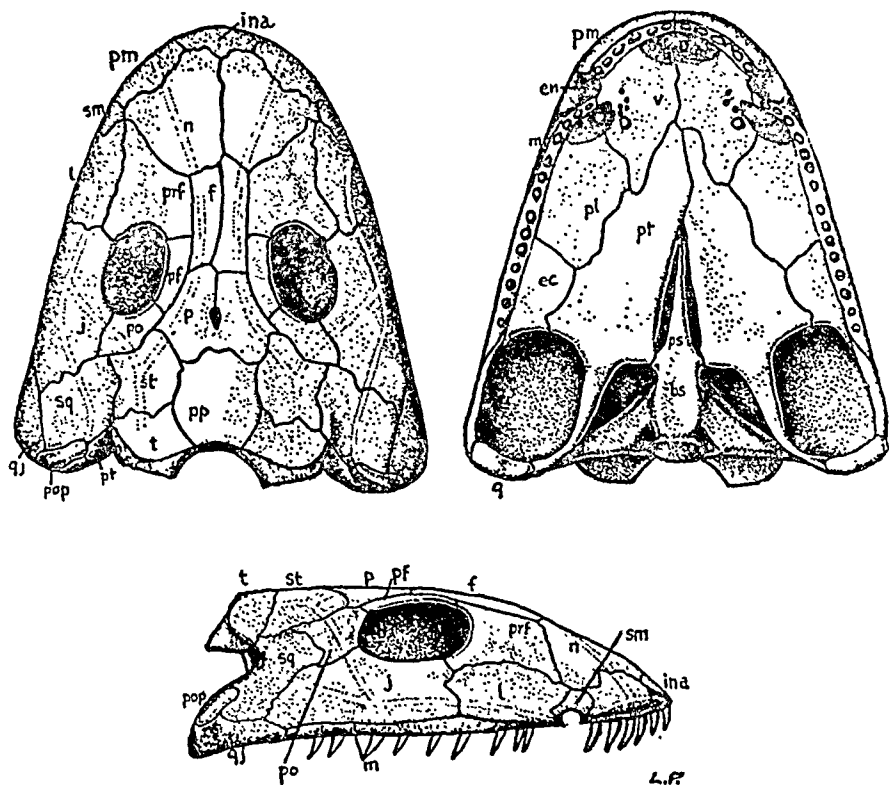


FIG. 3.—*ICHTHYOSTEGA*. A VERY PRIMITIVE AMPHIBIAN.

Note the distinct otic notch between tabular (t) and squamosal (sq). This animal has no oval window. Therefore it had no perilymphatic duct, and no middle ear mechanism. Its auditory function was undifferentiated i.e. Mechanisms No. 1 and No. 2. It certainly could not have had a tympanic membrane. Thus the so called otic notch has nothing to do with a tympanic membrane.

[Photograph from *Vertebrate Palaeontology*, A. S. Romer (p. 144), Univ. of Chicago Press.]

The perilymphatic duct passes forward from that point and the ducts of the two sides are joined together at the sinus impar S.i. This mechanism works as follows :

Air being very much more compressible than water, the swim bladder contracts and expands under the attack of a sound wave very much more

Evolution of the Auditory Perilymphatic System

violently than a corresponding volume of water would. The resulting movements of the wall of the swim bladder are further magnified by the action of the tripus which rocks en masse. These mass movements are conveyed to the perilymphatic fluid *viâ* the intervening ossicles. Mechanically this is closely comparable with the mammalian ear in which the tympanic membrane picks up the sound energy and converts it into

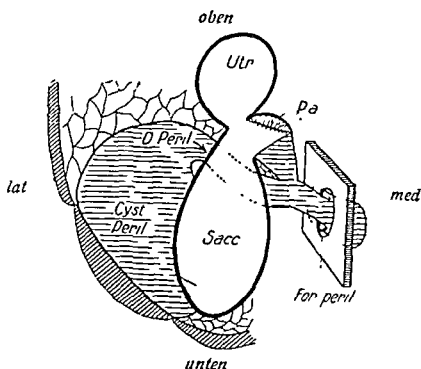


FIG. 4.—THE PERILYMPHATIC SYSTEM IN *PROTEUS ANGUINEUS*

Proteus (the Olm) is a lowly urodele which inhabits the dark caves of Carniola. Its perilymphatic system is mechanically primitive. The distal end of the duct lies within the cranial cavity which it enters at the foramen perilymphaticum.

Pa—pars amphibia—the portion of the saccular neuro-epithelium seconded for auditory function.

[Photograph from *Acta Otolaryng*, 1928 9 Vol. 13, p. 159.]

mass movement in the ossicles, which in their turn set the perilymph swinging.*

The membranous area in the wall of the fish auditory capsule has a function identical with that of the oval window of the mammal. In each case, it enables the mass movements in the conducting structures external to the braincase to be transmitted to the perilymphatic duct which has developed within the brain case, and it is clear that in the absence of such an oval window the external structures could have no possible value. (Pathological closure of this soft spot, such as occurs in otosclerosis results in profound deafness.)

* This close similarity has tempted some writers to argue that the structures are homologous. That is quite incorrect. As noted above, the fish's ossicles are derived from the transverse process of vertebrae, whilst mammalian ossicles have a quite different origin.

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The auditory conducting mechanism can thus be sub-divided into three distinct units as follows :

1. The receiving component, e.g., tympanic membrane or swim bladder.

2. The transmitting chain, i.e., the ossicles.

3. The terminal component, i.e., the perilymphatic system.

The mechanism of the fish and the mammal are by no means the only ones found in nature. I have elsewhere⁴ described the following six mechanisms :

(a) Vestibulo-squamosal (found in Urodeles).

(b) Vestibulo-quadrata (found in snakes and some lizards).

(c) Vestibulo-scapular (found in Anura).

(d) Vestibulo-hyoid (found in some lizards).

(e) Vestibulo-tympanic (found in many reptiles and birds).

(f) Vestibulo-ossicular (found in mammals).

These six mechanisms differ very much in respect to the receiving and transmitting components but they are all alike in possessing an oval window and a perilymphatic duct. However crude and inefficient the collecting and transmitting mechanism may be a perilymphatic duct, and oval window are always present. The reason for this is quite obvious. Hearing, so far as the vertebrates are concerned depends on the specialization of a portion of the neuro-epithelium of the sacculus. This is stimulated by *mass movement* of the perilymph, i.e., Mechanism No. 3.

In the absence of an oval window the vibrations of the tympanic membrane (or swim bladder) would not reach the perilymphatic duct. This would encounter and be dissipated by the whole mass of the chondrocranium. This is literally what happens in classical otosclerosis. It follows therefore that until the oval window developed, the other elements of the auditory conducting mechanism can only have existed—if at all—in a most rudimentary form. In particular—the tympanic membrane which is characteristic of the most exquisitely perfect and recently evolved mechanism—could not possibly have existed before the oval window. Comparative anatomy provides us with many examples of primitive mechanisms—primitive that is to say as regards the receiving and transmitting elements—but in every case the oval window and perilymphatic duct are present. Thus on the basis of both morphological and physical evidence we declare that any animal which does not possess an oval window cannot have hearing of the type of Mechanism No. 3. This dictum is of particular importance in considering the hearing in primitive amphibia.

Fig. 3 shows the skull of *Ichthyostega*, a very primitive amphibian. The notch between the tabular and the squamosal is called the otic

Evolution of the Auditory Perilymphatic System

notch because it is believed that a tympanic membrane was situated thereat. But *Ichthyostega* does not possess an oval window. Therefore it could not have possessed a perilymphatic duct and a fortiori it could not have possessed a tympanic membrane. The otic notch—whatever its purpose—certainly did not house a tympanic membrane.

It remains now to consider the round window. Figs. 4, 5 and 6 show the perilymphatic duct in a series of animals. We have defined the round window as the distal extremity of the perilymphatic duct and on the basis of this definition it appears that in *Proteus* it lies within the cranial cavity. This in fact is a very common finding in animals such as *Proteus* which possess very primitive hearing.

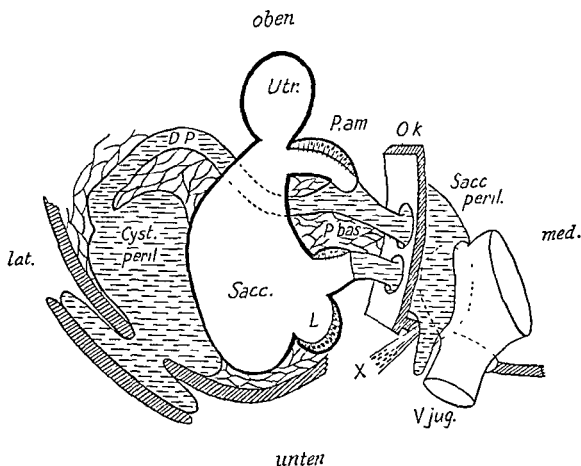


FIG 5 —THE PERILYMPHATIC SYSTEM OF THE FROG

Note that, in addition to the Lagena (of unknown function) the frog possesses two plaques of auditory neuro-epithelium, i.e. P.am—Pars amphibiorum and P.bas—Pars basilaris. The two ducts unite inside the cranial cavity to form the saccus perilymphaticus which then escapes via the jugular foramen.

[Photograph from *Acta Otalaryng*, 1928 9, Vol 13, p. 165]

The diagrams have in fact been arranged in ascending order of efficiency and it is apparent that increasing efficiency is associated with a migration of the round window from this primitive situation inside the cranial cavity to an intermediate situation on the jugular notch and finally on to the tubo-tympanic cleft. The latter situation is only found in animals which possess a perfect tympanic membrane. The significance

of this migration of the round window is obvious. The efficiency of any auditory conducting mechanism is closely related to the lightness and mobility of the perilymphatic system. In Fig. 4 the thrust of the stapes drives the perilymph against the counter resistance of the adjoining cerebrospinal fluid. In Fig. 6 the round window has emerged into air and the thrust of the perilymph only encounters the impedance of the air in the tubo-tympanic cleft. It thus appears that the evolution of the auditory conducting mechanism has been accompanied by a process of improvement both in the peripheral and in the central components. I have elsewhere shown that primitive animals possessed various types of crude receiving and transmitting components and that a long and tortuous process of development was necessary before the perfected

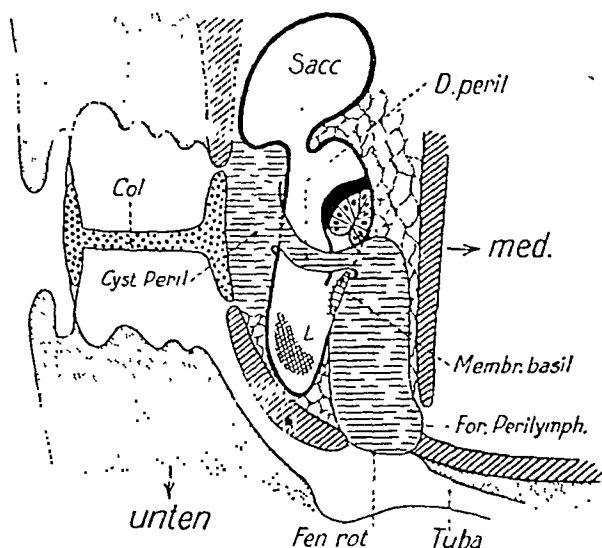


FIG. 6.—THE PERILYMPHATIC SYSTEM IN HEMIDACTYLUS (A Lizard).

Note how the ductus perilymphaticus still communicates with the cranial cavity at the foramen perilymphaticum but the main escape port is the Fenestra rotunda, opening on to the tubo-tympanic cleft.

This is—mechanically—the most efficient middle-ear mechanism with an air-borne membrane at each end, i.e. Tympanic membrane and membrane of round window.

[Photograph from *Acta Otologica*, 1928-9, Vol. 13, p. 174.]

tympanic membrane with its exquisitely balanced ossicles finally emerged. It now appears from this present discussion that a comparable process was occurring at the other extremity of the conducting chain and that the hall mark of real perfection is the simultaneous possession of air-borne membranes at both extremities. i.e., Tympanic membrane proper and the secondary tympanic membrane in the round window.

It should be noted that this argument is based on the tacit assumption

Evolution of the Auditory Perilymphatic System

that the auditory mechanisms found in lower animals today represent stages in the evolution of the middle ear. Reasons for this belief have been deployed elsewhere. Be that as it may, the evidence of palæontology, so far as it is available, does conform to the present argument. Fig 7 for instance, shows reconstructed casts of the inner ears of certain Therapsids. The oval window is easily recognized and so are the semi-

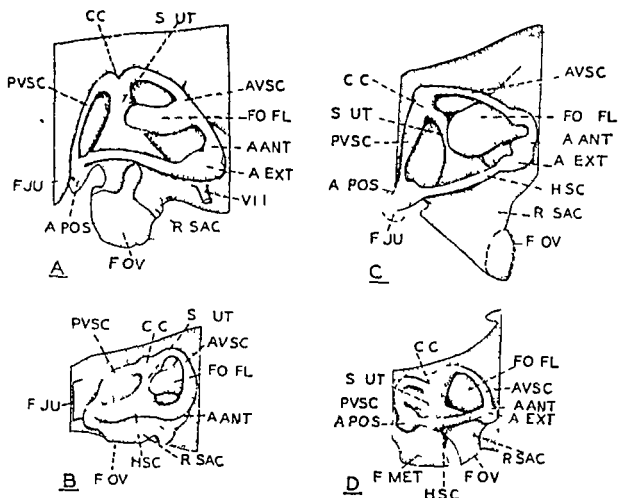


FIG 7—RECONSTRUCTED CASTS OF LABYRINTHS OF CERTAIN PRE MAMMALIAN REPTILES
LATERAL VIEWS OF CASTS OF LABYRINTHS OF GORGONOPSIDS A AND B THEROCEPHALIAN
B AND CYNODONT B

Drawn from wax models which were reconstructed from sections. Not to scale

A—Gorgonopsian B *Cistecephalus* zone C—Therocephalian B *Tapinocephalus* zone

B—Gorgonopsian A *Endothiodon* zone D—Cynodont B horizon uncertain

The three canals (HSC PVSC and AVSC) show up well with their ampullae (AANT APOS and AEXT)

The Fenestra ovale (FOV) opens on to the recess for the saccule (RSAC)

The Jugular foramen FJU is shown but there is no evidence of a round window. The perilymphatic duct must have ended in the cranial cavity as in *Proteus* or on the jugular foramen as in the frog

Photograph from Special Papers Geol. Soc. of America 1944 No 55 p 77

circular canals and the general cavity of the vestibule but there is no evidence of a round window opening externally. The presence of an oval window indicates that these animals did possess a perilymphatic duct, but the distal extremity of that duct, i.e., the round window

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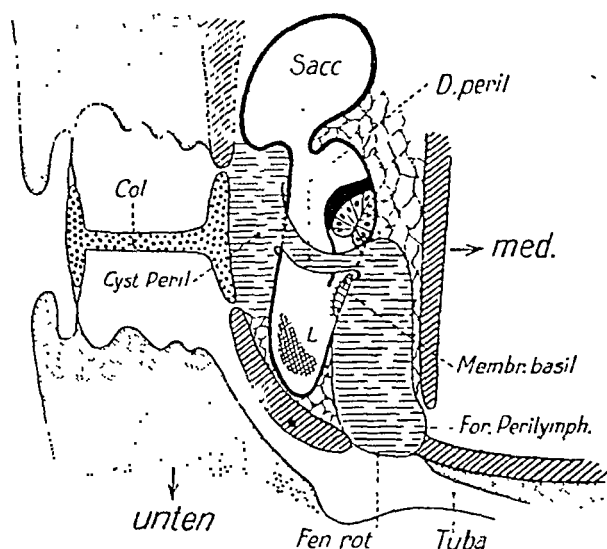


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migration is suggested—the hall mark of a perfect auditory mechanism being the existence of an air-borne membrane at both ends

The otic notch of primeval amphibia is discussed. The theory that it housed a tympanic membrane is shown to be without foundation

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CLINICAL RECORD

OSTEOMATA OF THE EXTERNAL AUDITORY MEATUS

A CASE REPORT

By A. BELAL, M.Ch. (Cairo), Lecturer, E.N.T. (Alexandria)

THE following case of osteoma of the external auditory meatus has been so unusually large that I felt it is worth recording. Examination of the literature shows that such tumours are usually very rare and small.

My patient, a male aged 30 years, complained of right-sided deafness which started ten years previously and was increasing gradually, this was accompanied with scanty discharge and the patient became conscious of a mass occluding his right ear. He did not complain of pain, headache or tinnitus. On examination there was a hard irregular glistening mass protruding out of and practically filling the right external auditory meatus looking very much like an aural polyp. It was hard and fixed, the covering skin was smooth but soaked in thin mucopurulent discharge. The mass was painless on touch and the temporomandibular joint was free. Hearing tests showed complete absence of air conduction but bone conduction was not affected. The left ear, nose and throat showed no abnormality. Radiograms confirmed the diagnosis of osteoma of the external auditory meatus but did not define a pedicle or the point of origin of the tumour.

Removal of the tumour was attempted as it was causing the deafness and interfering with drainage. Under general anaesthesia and through the usual post-auricular mastoid incision the mass was completely exposed after chipping off the post-meatal wall and the neighbouring part of the mastoid cortex. Dislocation of the membranous meatus from the bony one was not sufficient and that is why I thought of removing a part of the bony posterior meatal wall together with the adjoining mastoid cortex. This last step actually gave me a very good exposure and made it possible to remove such a big mass more easily and thoroughly than with omitting it. The mass was found to be attached by a broad base to the antero-superior corner of the bony external auditory meatus. The soft tissues were put back in place and meatal examination revealed a central perforation of the drum-membrane. The operation wound was stitched up leaving a small drain at its lower end. The raw surface in the meatal wall was covered by a pack of gauze saturated with penicillin-sulphadiazine emulsion. With anti-bacterial chemotherapy and repeated intrameatal dressings with the stated emulsion the ear discharge stopped completely after two weeks and the perforation healed in about a month and thus a wide healthy meatus was obtained. Hearing was restored to normal limits six weeks after operation.

Histologically the mass revealed a bony tumour of ivory nature. Osteomata in this region are ivory in type as they arise in relation to membrane bone from which all the bony external auditory meatus is embryologically developed.



FIG. 1
Before operation



FIG. 2.

After operation.

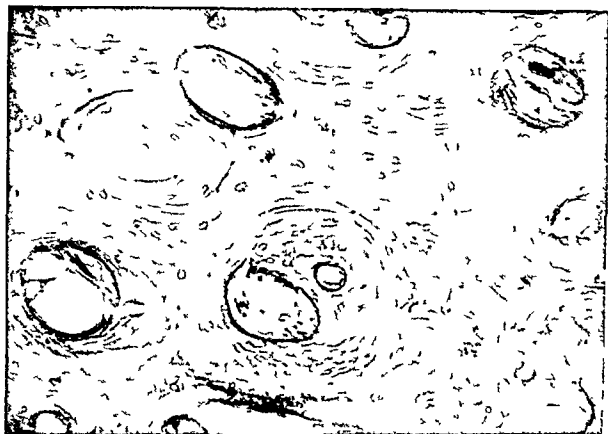


FIG 3

Microphotograph of the tumour

Clinical Record

It is worthy to note that the site of attachment of the mass is closely related to the centre of ossification of the squamous part of the temporal bone.

A picture of the patient showing the mass in place before operation (Fig. 1) and his picture after operation (Fig. 2) as well as a microphotograph of the histological picture (Fig. 3) and a diagrammatic drawing of the mass in natural size (Fig. 4). There are no X-ray photos.

I like to express my deepest thanks to my colleagues of the X-ray and pathological department for their co-operation.



FIG. IV.

Diagrammatic picture of the tumour—natural size

SOCIETIES' PROCEEDINGS

THE SCOTTISH OTOLOGICAL AND LARYNGOLOGICAL SOCIETY

Proceedings of the Scottish Otological and Laryngological Society, Saturday, 29th May, 1948, in the Ear, Nose & Throat Department of the Royal Infirmary, Foresterhill, Aberdeen.

President : DR. STRANG, (Glasgow)

CASES AND DISCUSSION

Cases I-VI.—Dr. JOHN GERRIE.

(I) *Acute Exacerbation, Chronic Suppurative Otitis Media, left, with Temporo-sphenoidal Abscess.*

A.W., aged 20.

29.4.47. Admitted to Aberdeen Royal Infirmary with history of discharge from both ears, especially left, for as long as he can remember. Seven weeks previously had influenza. Aural discharge worse : been unwell with left-sided headache for the past three weeks : dull and apathetic for last twenty-four hours : mother noticed speech confused.

Examination. Tenderness over left mastoid : profuse discharge : postero-superior perforation with granulations. Right ear—muco-pus present : antero-inferior perforation. C.N.S. examination negative. Lumbar puncture—slight pressure : clear fluid.

29.4.47 Cortical mastoidectomy : pus and granulations in mastoid antrum : lateral sinus and dura widely exposed, found normal : mastoid sclerotic. Wound left open.

1.5.47. Disorientated : temperature swinging : papilloedema both eyes.

5.5.47. Papilloedema increased.

6.5.47. Impossible to chart fields because of general condition. Lumbar puncture—clear fluid : pressure 180 mm.s. General condition worse. Physician reports—"Cerebration drowsy and slow : right hemiplegia : double optic neuritis and probably word blindness".

8.5.47. Radical mastoid operation, left. Temporo-sphenoidal lobe abscess found and drained.

2.6.47. Drainage discontinued.

13.6.47. Wound healed : ear dry : discharged.

23.4.48. Seen again. C.N.S. normal on examination : both ears dry.

Case I. Dr. LAND said that he saw from the history that the mother had noticed that speech had been confused. Had Dr. Gerrie anything to add to this and was there any definite aphasia or speech difficulty when the patient was first examined?

Dr. FULTON CHRISTIE said he would like to congratulate Dr. Gerrie on this case. Cases of this type were shown at most meetings of the Society and,

The Scottish Otological and Laryngological Society

in view of the changing outlook on the treatment of intracranial complications since the introduction of penicillin and the sulphonamide drugs, he thought that the time had come for the Society to have a discussion on the subject. His own view was that such cases should be handed over to the neuro surgeon for treatment at the earliest possible moment. Even lumbar puncture was not always without danger and tapping of the ventricle might be preferable.

Dr HOWIE said that in the reports of the cases for the billet he thought they should make more complete notes on the state of the C S F. He would suggest that pressure should always be recorded, and that the cell count, result of culture, sugar, protein and chlorine estimations should be put down. Only by seeing these recorded regularly can an opinion on intracranial cases be formed. He thought that as a body the otologists should learn to do a lumbar puncture properly to avoid the danger of coning.

In reply to the various questions Mr GERRIE said that the central nervous system was negative prior to operation. The drainage used was a rubber tube. There was no question of placing this case in the hands of the neurosurgeon as he had only arrived in Aberdeen a month ago. The patient received 5,000,000 units of penicillin.

(II) *Dacryocystorhinostomy*

Miss S., aged 63, complained of watering of left eye for many years occasional purulent discharge. Obstruction found in naso lachrymal duct.

2 3 48 Left Dacryocystorhinostomy

5 3 48 Pack removed wound healed

7 3 48 9 3 48 Opening into nose found patent by syringing

19 4 48 Seen again no further trouble

Dr MARTIN said he thought this case was rather out of their line. In the olden days when the E N T surgeons had done the operation it was called a West operation, draining the sac from the inside. This had now been superseded in Edinburgh by the Toti operation, the operation being done by the ophthalmologist the E N T surgeon merely being asked to examine the nose prior to the operation for fear of any infection being present.

Dr MATHERS said he could not agree with Dr Martin. He had done two or three cases with the ophthalmologist. He had seen J T Simpson London, do this operation and he made a right angled incision in the nasal mucosa and the sac, then brought the two layers of the mucous membrane together. The results had been good.

Dr SMITH said that many years ago he had worked with the late Dr Fraser, who was very keen on the West operation. He was of the opinion that the really purulent types of dacryocystitis were not suitable cases for the West operation. The Toti operation therefore, superseded the West completely. He thought the West operation did best in the mucous type of dacryocystitis.

(III) *Adenoma of Trachea*

W W., aged 46

12 1 48 Complaints of stridor with extreme breathlessness for three weeks. He noted that he had been becoming more breathless for the past year. no hoarseness.

Societies' Proceedings

Examination. Larynx—large round smooth plum-coloured swelling in subglottic region : cords move freely on phonation.

13.1.48. *Bronchoscopy*—Tracheal polyp removed under local anæsthesia. It was attached by rather a broad base to the posterior and right lateral walls of the trachea. Pathological examination showed an adenoma.

23.4.48. *Indirect Laryngoscopy*—Larynx, apart from some injection, is normal.

Dr. MARTIN asked the position of the adenoma in the trachea. He said a lot of work on this subject was being done in America and he expected more to be published about it in the near future.

In reply to Dr. Martin, Mr. GERRIE said that the tumour was sub-glottic on the posterior wall. There was one thing which was worrying him and that was the possibility of recurrence. He remembered Professor Young showing a case of an adenoma of the bronchus, part of the tumour lying on the wall of the bronchus and part in the tissues outside. If this patient developed a recurrence outside the trachea treatment was going to be very difficult.

(IV) *Laryngeal chondroma.*

G.S., aged 47.

15.2.42. Hoarseness one year, following a cold : feeling of foreign body in the throat.

Larynx—Complete immobility right cord, with compensation. Examination revealed no cause.

28.2.45. Seen again complaining of stridor. Indirect laryngoscopy showed the right cord still immobile, but there was a smooth subglottic tumour present in the region of the posterior third of the right cord, extending to the middle of the inter-arytenoid region.

10.3.45. *Direct Laryngoscopy*—Tumour found to be densely hard. Biopsy showed "cartilage".

19.3.45. Laryngo-fissure with preliminary tracheotomy. Big mass size of one shilling on right posterior aspect of subglottic region with foul necrotic centre. The base was on the cricoid, passing on to the lower part of the thyroid cartilage and first two rings of trachea. Tumour removed, and base scraped with spoon.

24.3.45. Tracheotomy tube removed. Convalescence otherwise uneventful.

20.4.48. Seen again. General condition very good. Right side of larynx still immobile, but otherwise free.

Dr. HALL asked if there had been any question of malignancy in this case.

Dr. MARTIN asked if the patient had been examined recently by the direct method. He had managed to get a fairly good view with the mirror and there appeared to be an area about 1 inch below the cord which looked rather necrotic.

In reply, Mr. GERRIE said there was no question of malignancy. There was a very foul mass lying in the subglottic region. Unfortunately the patient was rather difficult to deal with as regards treatment though he was a very nice fellow.

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(V) *Carcinoma of post cricoid region*

Mrs E, aged 54

6 7 42 Pain on swallowing, referred to left side cricoid, for two months, becoming worse No great difficulty in swallowing Always had a "narrow swallow" No hoarseness Some loss of weight

Indirect Laryngoscopy—Mucus and food debris lying in hypopharynx left arytenoid swollen, and on phonation a tumour could be seen coming up towards the left pyriform fossa Glands present left side, along anterior border of sternomastoid

15 7 42 *Œsophagoscopy*—On left side hypopharynx, extending half way round the mouth of the Œsophagus, there is a shaggy surfaced carpet of tumour, bleeding readily on touching

Biopsy Report—"The tumour is a papillary squamous carcinoma"

19 7 42 By Mr James Graham of Edinburgh—Trotter's Lateral Pharyngotomy with preliminary tracheotomy The lymph glands and left lobe of thyroid gland were removed Whole segment, wide of the tumour, consisting of lower end pharynx and upper end Œsophagus, removed, and lower end pharynx and upper end Œsophagus attached to skin flap with skin gutter left between the openings Glands found not to be involved

22 1 43 *Second operation*—Plastic repair of cervical Œsophagus

30 4 48 Seen again Swallowing normally only difficulty with oatcakes Neck soundly healed left cord fixed

Case V Dr YOUNG said he thought this was a very good example of a Brown-Kelly-Paterson syndrome with fissures at the corner of the mouth and a smooth red tongue He thought this case would benefit with iron This, of course was incidental to the malignant condition

(VI) *Mycosis Fungoides with Addison's disease*

Mrs M R, aged 50

This patient has been in hospital intermittently since 1943 with Mycosis Fungoides of the skin and mucous membranes She presents typical lesions on the skin and in the pharynx and she has been treated by X-ray therapy and Urethane

During her Urethane treatment she developed an acute attack of Addison's disease, due, in all probability, to deposits in the adrenals

The Addison's disease was controlled by Eucortone, and finally, on 5 8 48, 300 mgms of DOCA was implanted in the subcutaneous tissue of the posterior axillary line on the right side

She has been admitted again for further Urethane treatment

Case VI Dr MARTIN said he would like to congratulate Mr Gerrie on this case He understood there were only 4 such cases and he would look forward to hearing more about this case at a later date

Mr GERRIE said that the patient was at present in the Skin Ward and was keeping fairly well The condition was a reticulosis, usually lasted about 5 years and ended fatally It was not often that the lesion attacked mucous membranes and treatment was rather difficult The interesting thing about this patient was that it was associated with Addison's disease

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pre-cancerous, although no evidence of invasive growth is actually found in the sections examined."

31.1.47. *Fenestration Operation*—Six radium needles inserted. Dose—2,000 mgm. hours.

20.2.47. Discharged.

He has been kept under observation since.

Case VIII. Dr. COLLINS said he brought this case forward as it was a problem they were constantly meeting. Although there was nothing very definite in the pathological report of the biopsy, yet the clinical appearance strongly suggested that the condition was malignant. He recalled a discussion at the Royal Society of Medicine in 1930, when Chevalier Jackson and Sir St. Clair Thomson both discussed this condition. Sir St. Clair Thomson contended that these leukoplakias were often pre-cancerous though the pathology was indefinite. After discussion with the Radium Officer, they had decided to treat this case by means of a fenestration operation so that a large dose could be applied to this pachydermatous mass. They did not expect the radium to influence the pachydermia but they hoped that it would destroy any malignant cells which were present. The actual dose which was given amounted to 8,600 r. and not 2,600 r. as stated in the Billet. Since the treatment, the ulceration had disappeared but there was still a little polyposis of the edges of the vocal cords. The swelling of the false cords also seemed rather less. His only fear was that there was a slight risk of irritating the cancer cells if an insufficient dose reached them.

Dr. YOUNG said he thought that the present swelling and local congestion was the result of the irradiative treatment.

Dr. HOWIE said that two of the cases of total laryngectomy which he had shown last year at the Glasgow meeting of this Society had keratosis before developing frank malignancy. The man of 67 years of age when operated on had been troubled for 15 years with keratosis which had become malignant. The other patient was the only woman in the group. She had been husky for 10 to 15 years. Clinically keratosis was the condition but a biopsy proved it to be an early malignancy. In a personal communication Mr. Negus told him that he always watched keratosis as it was liable to show a malignant change later, and it proved so in these cases.

Dr. SMITH wished to know why the fenestration operation was performed? Why was deep X-ray therapy not used?

In reply Dr. COLLINS said treatment had been discussed with the Radiologist and it was felt that a larger dose could be obtained by means of radium than from deep X-ray therapy. In his view the only alternative form of treatment would have been some form of hemilaryngectomy but the patient was not keen to have this done.

(IX) *Cardiospasm: Traumatic Perforation of Œsophagus: Empyema left chest—Drainage of Empyema: Gastrostomy: Recovery.*

Mrs. N., age 38.

History.—Increasing dysphagia for cold fluids and solids of twelve years' duration. No regurgitation. X-ray shows well-marked cardiospasm lower end of œsophagus.

Societies' Proceedings

9.12.46. *Œsophagoscopy under Pentothal and Curare*.—Cardiac sphincter dilated with Jackson bougie, and then with larger olive tipped gum elastic bougie. Normal adult size Jackson œsophagoscope used.

11.12.46. Signs of pressure pneumothorax left. Reduction of pressure and aspiration of one pint of mawkish yellow fluid (Dr. Duthie). Half million units pencillin. Aspiration continued daily until 16.12.46.

16.12.46. Drainage of empyema left chest (Mr. W. Anderson). Considerable quantity of fluid removed—large mass of fibrinous lymph deposits covering the surface of the lung. Lung completely collapsed and lying posteriorly.

16.12.46-19.12.46. Gradual but slow deterioration of general condition. Chemical examination of pleural fluid showed some regurgitated stomach contents with a very acid fluid, as though auto-digestion was going on near the perforation.

19.12.46. Gastrostomy (Mr. W. Anderson). Stomach alkalinized with aludrox.

31.12.46. X-ray shows a left pleural cavity free of fluid: lung still collapsed.

19.1.47. Gastrostomy tube removed. Patient swallowing soft foods without difficulty.

16.2.47. Patient discharged.

Further X-rays, done up to 11.12.47, showed complete re-expansion of left lung. Œsophagus quite patent, and shows no dilatation, but there is a little irregularity of the outline of the gullet in the lower third, probably due to some residual thickening and adhesions. There is no delay in the passage of moderately thick barium into the stomach.

Case IX. Dr. COLLINS said this case reflected no great credit on himself but he felt that he had learned a great deal from it and wished to pass on his experience to some of the younger members. The original œsophagoscopy was easy. At the time he was not aware that he had caused any damage so that it came as rather a shock when the chest complication occurred. These traumatic perforations of the œsophagus had been discussed in an article in the *Annals of Otology and Laryngology* last year. There were two schools of thought with regard to treatment. The first school advised early operation together with chemotherapy and the second advised a waiting policy with the injection of massive doses of penicillin. He himself favoured early operation and he thought that in this case, there might have been something gained if gastrostomy had been performed when the empyema was drained. He felt that there were three points of interest in this case. The first was how far Curare had contributed to the traumatic perforation of the œsophagus? Might it not make the muscle coat of the œsophagus more atonic and the risk of a perforation greater? The second point was the question of early operation which he had already mentioned. The third point was the power which the lung had of re-expansion, even when it has collapsed down to a size which is no greater than one's fist and the pleura is covered with thick masses of lymph. Though the cure had been very drastic, the patient was now very well with no difficulty whatsoever in swallowing. In fact, her only complaint was that she had put on about two stones in weight.

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Dr HOWIE said that Dr Collins is to be congratulated on bringing this case before the Society. He had actually had two similar accidents, one small child had swallowed lye, and this was followed by marked stenosis of the œsophagus. He had put in an indwelling catheter through a left-sided cervical œsophagostomy. After this was removed she swallowed fairly well but had to be kept on bouginage. One day there was a complaint of severe pain in the chest and this was accompanied by a sharp rise in temperature. Surgical help was called in and the question of mediastinotomy considered. A gastrostomy was done and the child put on massive doses of penicillin. She made a steady recovery. The other case was a woman whose condition had been diagnosed as cardiospasm. She underwent regular bouginage without anaesthesia, and although she had discomfort on some occasions, it was after regular treatment for about 3 weeks that she complained of severe pain mainly on the left side of the chest. Fluids by the mouth were withheld for 24 hours, and twice daily penicillin in 500 000 unit doses were instituted. She settled down quickly and was now all right. In the past such accidents were almost invariably fatal. He felt if such damage was suspected penicillin should be used in bulk straight away.

Dr MARTIN said he concurred with all Dr Howie had said. In the days of Dr Logan Turner and Dr Fraser they had held discussions at the end of each endoscopic session as to the treatment of such cases and he thought quite a lot could be learned from such discussions. He, personally, had had two similar accidents. One was in a child who had swallowed sulphuric acid. After one œsophagoscopy examination he realized he must have perforated the œsophagus with the ease with which the tube passed. The child was put on penicillin and left alone for 24 hours. An X-ray of the chest was requested but the radiologist either received the wrong message or misunderstood it and gave some barium. He was rather surprised to see this leak through a hole in the œsophagus. A gastrostomy was then performed and the child given some food. An empyema developed due to the leak of barium through the œsophagus. The curious thing was that the gastrostomy seemed to cure the stenosis and he found this in two previous cases.

He would like to ask if Dr Collins' use of the olive tipped bougie had anything to do with the accident.

Dr COLLINS in reply said that he had used the Jackson bougie in the first place before the olive tipped one.

(X) *Hypopharyngeal Diverticulum Operation*

W H, aged 70

21 8 47 Admitted Aberdeen Royal Infirmary with increasing dysphagia for a year. Feels food sticking at back of throat. No regurgitation. Lost two stones in weight. Under treatment for coronary thrombosis.

Examination showed frothy mucus in both pyriform fossae. X-ray diverticulum lower end of pharynx, 4 cm s in diameter, causing compression of upper end of œsophagus.

29 8 47 *Œsophagoscopy*—(Œsophagoscope passed into pouch. Small stoma of normal œsophagus seen on anterior wall.

10 10 47 Lead shot on thread swallowed. X-ray shows it in stomach.

Societies' Proceedings

13.10.47. Under Pentothal Trilene anæsthesia, diverticulum was dissected free, the pouch having been identified by passing an œsophagoscope. Outer layers of pouch dissected downwards in the form of a cuff. Sac divided at neck, and closed by continuation suture. Two rows of interrupted sutures superimposed. Corrugated rubber drain at lower end of wound after deeper layers sutured. Rubber tube inserted for Penicillin instillations of 8,000 units per c.c. eight hourly.

Progress. Heart irregularity after operation, and some bronchitis. Wound completely healed in ten days. Some left recurrent laryngeal paralysis, but hoarseness not marked.

Case X. Dr. COLLINS said he had followed the Jackson technique in this case. They admitted the patient three or four days before operation and washed out the pouch. They then asked the patient to swallow a lead shot attached to a thread which eventually found its way into the stomach, as confirmed by X-ray. He had found, at operation, that this passage of thread made the recognition of the anteriorly placed opening into the œsophagus proper, easier.

Cases XI-XIII.—Mr. I. P. J. MACNAUGHTON.

(XI) *Mènière's Disease.*

R.W., aged 48.

8.11.47. One year's history of vertigo, tinnitus and vomiting. Clinical examination essentially negative.

Audiometry.—Marked nerve deafness right: High tone loss left.

Calorigram.—Within normal limits: Histamine sensitivity plus

15.11.47. Histamine diphosphate 2.75 mgm. in 250 c.c. of physiological K.C.L. by slow intravenous drip.

18.11.47. Repeated. Weekly injections of 0.5 mgm. histamine diphosphate hypodermically.

16.2.48. Course completed.

28.3.48. Symptom free: hearing as before.

Calorigram.—showed right canal and utricular paresis and right utricular paresis.

Case XI. Dr. MACNAUGHTON said he had shown this case as an example of the Histamine treatment. It was the first case he had treated in Aberdeen by this method and though the result was not brilliant the patient had been free of attacks for 8 months. He had had an attack recently. The labyrinth had degenerated during the time he was free from attacks. As in all new treatments of Ménière's Disease there appeared to be an initial success but it would be interesting to see if there was any real benefit in say 4 or 5 years. In reply to Dr. FULTON CHRISTIE, Dr. MacNaughton said that the patients were selected for histamine treatment by the histamine skin sensitivity test as described by Mr. Atkinson.

(XII) *Mumps: Neurolabyrinthitis.*

J.M., aged 39.

13.3.48. Complains of deafness in the right ear following an attack of mumps five weeks previously. At that time vertigo and headache were severe, and unsteadiness has persisted.

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Examination — Both drums appeared normal. There was a first degree nystagmus to the left, and he was stone deaf in the right ear.

Audiograms and calorigrams are shown.

Case XII Dr SMITH said he had been very interested in this case because one week ago he had examined a patient of the same age at the Edinburgh Royal Infirmary and at first thought it might be the same case but the Aberdeen patient said he had never been in the Edinburgh Royal Infirmary. One rarely saw giddiness with a mumps deafness. He would like to know the pathology of these cases, but, as most of the patients would live longer than he would, it was extremely difficult to obtain pathological specimens.

(XIII) *Syphilitic Laryngitis with carcinomatous change*

A N, aged 57

17 4 48 Complained of loss of voice for four months following a cold.

Examination showed the pharynx healthy, but the larynx had an ulcerated mass below the level of the left true cord involving the cord. There was also swelling and reddening of the false cord.

22 4 48 *Direct Laryngoscopy and Biopsy*

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Chest X ray — "Peri bronchial thickening"

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This is the third successive case of carcinomatous change in a syphilitic laryngitis we have seen in three months.

Case XIII Dr MACNAUGHTON said he had shown this case as one of three in which there was a carcinoma with fairly extensive ulceration complicated by the presence of a specific infection.

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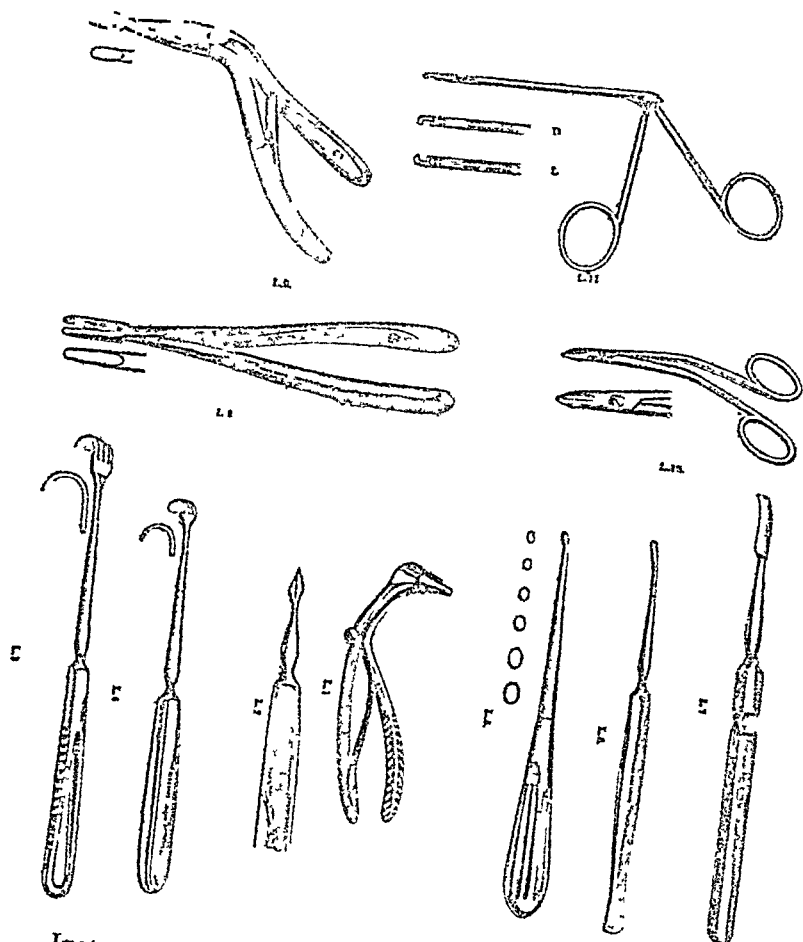
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WITH THE ASSISTANCE OF
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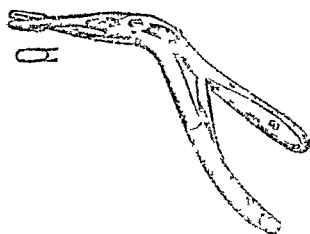
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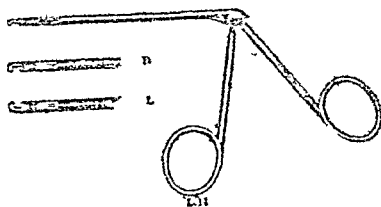
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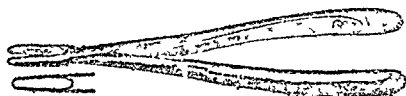
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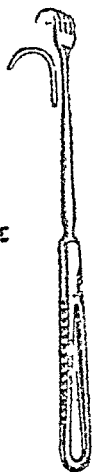
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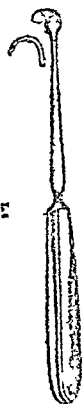
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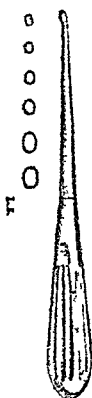
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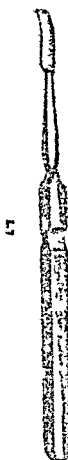
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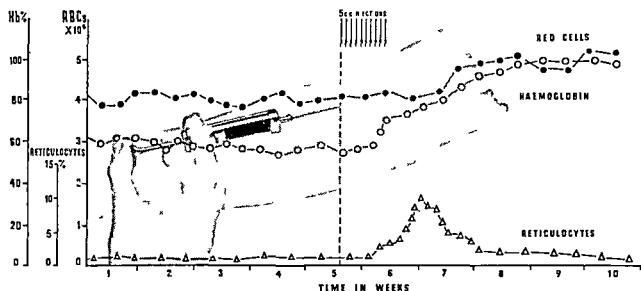
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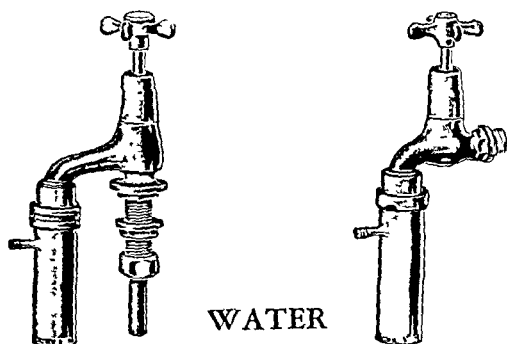
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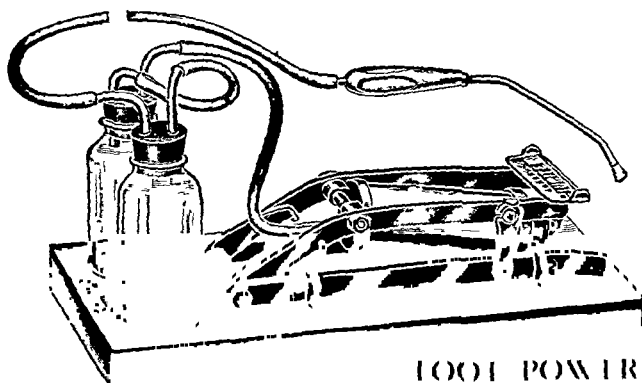
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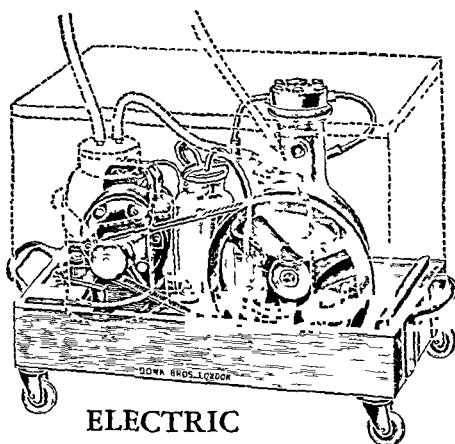
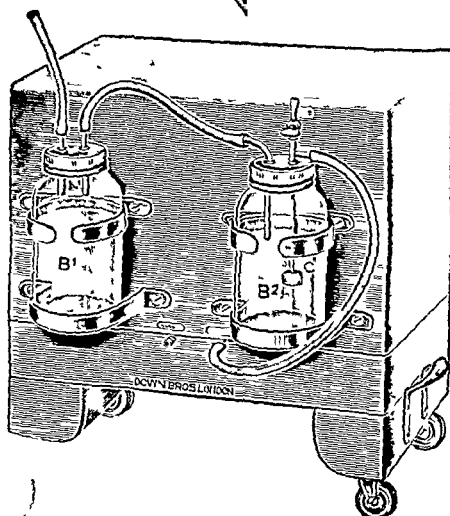
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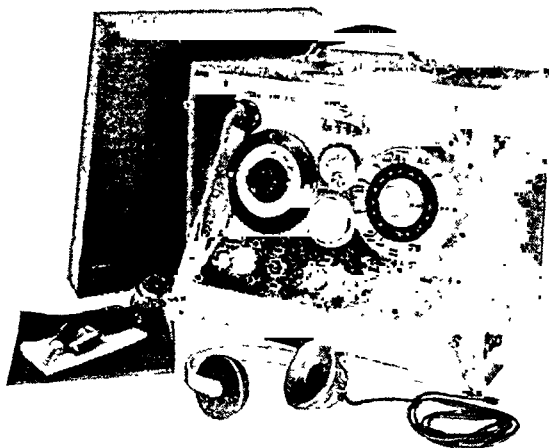
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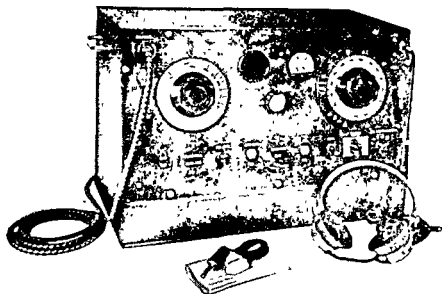
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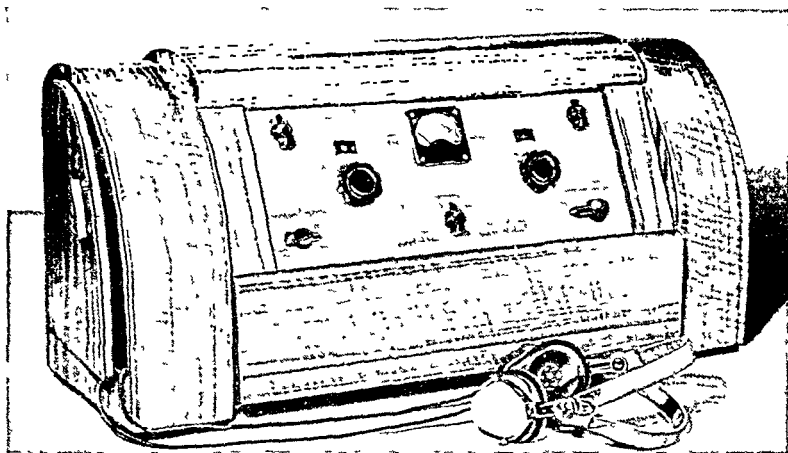
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December 1948

PINS IN THE PERIPHERY OF THE LUNG

By GILROY GLASS (Nottingham)

PINS in the periphery of the lung are fortunately rare. The Jacksons,¹ writing in 1932 record 113 cases of pins in the bronchi in only 42 of which the pin had reached the periphery. Ewart Martin² has had two cases only in his Department in Edinburgh in over 25 years. In the clinics in Nottingham and Mansfield serving a population of 600,000 there have been but two cases in the past twenty years. The writer has been able to trace only two cases in the literature during the past ten years.³

While it would be dangerous to generalize from a limited experience of two cases, in a condition so relatively rare the experience of the problems and their solution may be of interest to others who may be faced with the same difficulties, and have the same limitations of equipment. In the first case, a girl aged 13, the pin lay in the costo-phrenic angle of the left lower lobe, and was successfully removed at the third attempt. In the second case the pin lay deep in the cardiac segment of the right lower lobe, and was removed at the second attempt. In each case there was an interval of ten days between attempts, this being the minimum time considered advisable owing to dosage of X-ray. There would seem to be no danger in such delay. There was no sign of reaction in the lung and X-rays showed that the pin had not changed its position. This is borne out by one of Ewart Martin's² cases, an infant of ten months, in which removal proved impossible. Four years later the position of the pin had not changed, nor had the child's health suffered unduly.

The question must arise as to how often it would be justifiable to repeat attempts to remove the foreign body under the fluoroscopic screen. The absence of marked reaction certainly permits of considerable delay, but it seems reasonable to suggest that three or perhaps four unsuccessful attempts, especially if the pin has been accurately located,

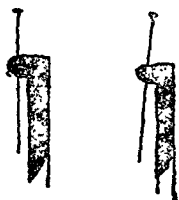
Gilroy Glass

indicate that the pin must be impacted and further attempts would be futile.

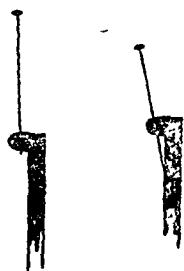
The writer has had no experience of pins in the periphery of the lung which are already giving rise to symptoms, but Negus,⁴ writing on this subject states, "If a pin is in the periphery of the lung and causing any trouble, such as the formation of granulations with hæmoptysis, it would be right to attempt removal under radiographic guidance, but if this were ineffective, it would then be right to refer the case to a thoracic surgeon, who would either milk the pin down and remove it through a small nick in the pleura, or would take out a triangular section of the lung with the pin contained. Nowadays thoracotomy and partial lobectomy have become relatively safe and preferable, in the opinion of some thoracic surgeons, to endo-bronchial methods which are difficult to control. I am not suggesting for a minute that thoracotomy should be resorted to in the first place, but only if two or possibly three attempts at bronchoscopic removal have failed."

If symptoms have not arisen there is the lesson of Martin's case mentioned above that little harm arises from delay.

Jackson¹ has pointed out that pins in this situation always lie head downward, and find their way to the periphery by a ratchet action. This tendency for the point to impact adds to the difficulty and danger of their endoscopic removal. The methods he recommends to overcome this difficulty are either to use a costo-phrenic bronchoscope into which the pin is bent, or to use a pin bending forceps. Neither of these methods can, of course, be used if the pin is of steel or otherwise unbendable.



Pin liable to impact.



Pin unlikely to impact.

The second problem of foreign bodies in the periphery of the lung is visualization. They lie beyond the range of vision of even the costo-phrenic bronchoscope, and fluoroscopy presents the only possibility of visualization. On this subject the Jacksons in their classic volume *Diseases of the Air and Food Passages of Foreign Body Origin*⁵ write :—

"When we speak of a fluoroscope for bronchoscopy we mean a double plane fluoroscope, that is, one which will present on the screen promptly at will, either the antero-posterior or the lateral projection without

Pins in the Periphery of the Lung

rotation of the patient with the bronchoscope in situ, not only because of the possible slight risk of the trauma, but because displacement of the relation between the foreign body and the tube mouth would be inevitable and would defeat all efforts at accurate placements of the forceps. A single plane fluoroscope is altogether unsuitable for bronchoscopic aid because it is misleading. The use of parallax as an aid in the determination of proximity in the other plane is of comparatively little value."

Such a council, backed by the unparalleled experience of the Jacksons, is a council of perfection. It may be true that "The use of forceps guided only by a single plane fluoroscope is an exceedingly dangerous procedure,"⁶ but there are occasions when something short of the ideal has to take its place. Double plane fluoroscopes are few and far between in this country—and in the present state of Europe may remain so for a long time to come—and few clinics are equipped with the instrumentarium of the Jackson clinic. Moreover, in a broad chested subject where the shadow of the pin is superimposed on the cardiac shadow visualization on the lateral screen may be very difficult or even impossible, a misfortune which occurred in the writer's second case. It is not suggested that removal of pins from the periphery of the lung should be undertaken lightly or with a very inadequate instrumentarium, but with extreme care pins can be removed successfully without either a double plane fluoroscope or pin bending forceps. Two cases is a small number on which to base a technique, but even two cases brought to a successful conclusion must at least demonstrate the possibilities of a method.

As has already been mentioned there are two distinct problems the problem of visual grasping of the foreign body, and the problem of disimpaction and removal without piercing or sticking in the wall of the bronchus.

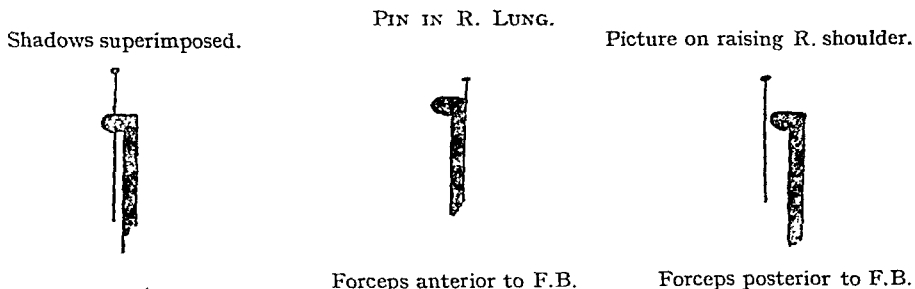
When, as in the periphery of the lung, the foreign body is beyond the reach of the bronchoscope, the fluoroscopic screen is the only possible means of visualization. Jackson's advice that the skilled radiologist used to fluoroscopy will see more, and will interpret more accurately what he sees than the bronchoscopist, cannot be too strongly stressed. The bronchoscopist must, naturally, see what he is doing, but he must be prepared to defer to the opinion of the radiologist throughout. At the time when the first case was met with (1938) double-plane fluoroscopy could not even be improvised. At the time of the second case (1948) double plane examination was possible, although there was delay in switching from one plane to the other, owing to the type of plant, which is not made for this specific purpose. However, as already mentioned lateral visualization was so imperfect as to be, in the radiologist's opinion of less value than the method we had already devised.

The difficulties of single plane localization have to be experienced to be

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believed. Study of a bronchogram would suggest that no two of the finer bronchioles run at exactly the identical angle, even on one place, and that therefore it would be easy to tell if the forceps were in the correct bronchiole. In practice the lung tissue is so elastic that the rigid forceps can and will displace the bronchiole several degrees. This is particularly evident in the early stages if the endoscopist watches the screen too closely. There is inevitably a tendency to aim the forceps tip at the foreign body and thereby displace the angle of the bronchioles. Having decided from the initial X-ray pictures which branch is likely to be affected, the endoscopist should pass the forceps without watching the screen, and be guided entirely by the radiologist, the tendency to "aim" is thereby reduced. It is only when the forceps are apparently correctly located that the endoscopist should watch carefully the screen. When the shadow of the forceps and that of the foreign body are superimposed it is by no means certain that they lie in the same bronchiole. It is at this stage that the difficulties and dangers commence.

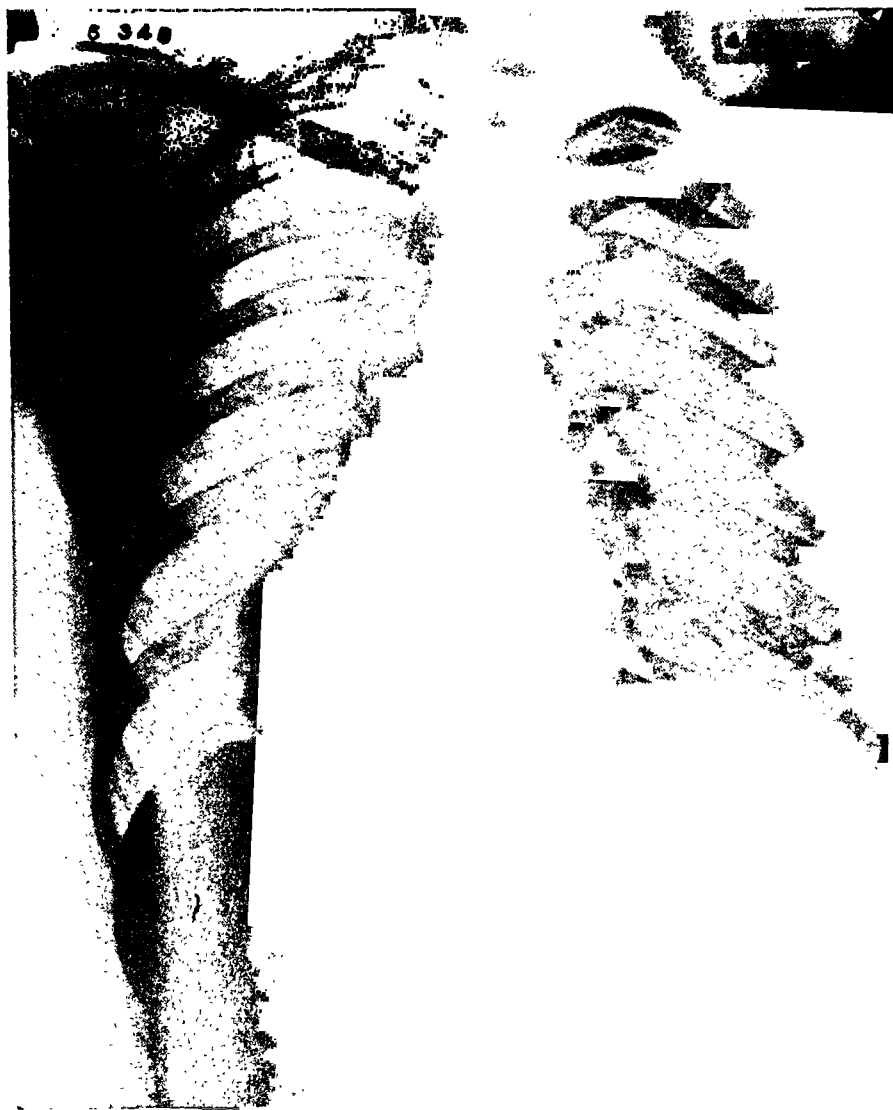
In the first patient two unsuccessful attempts were made before the pin was successfully removed. At each the shadows were superimposed, but gentle manipulation of the forceps failed to indicate that the forceps were in fact in apposition to the pin and the attempt was abandoned after 15 minutes to avoid over-dosage of X-rays. On the third occasion it was decided to attempt to locate more accurately by rotation. Full rotation to the lateral position being regarded as both impracticable and risky, the services of an additional assistant were enlisted to raise the shoulder of the affected side a distance of two to three inches when required to do so. Even this small amount of rotation proved exceptionally valuable. If the forceps were in a bronchiole anterior to the pin, the forceps tip appeared to move medially in relation to the pin, if posterior, laterally. It was surprising how close the two radio-opaque bodies could be and still show this variation in relative position.



Opportunity of confirming the value of this observation did not occur for ten years. Making use of it the pin in the second case was located rapidly and accurately.



CASE II Lateral view



CASE II. A.P. view.

Pins in the Periphery of the Lung

Having located the pin accurately, the problem changes. It must be assumed that in the majority of cases the normal contraction and expansion of the lung will have brought the point of the pin into very close contact with the wall of the bronchus, if indeed it is not already pierced. It must therefore be disimpacted before it can be removed. Ideally, once disimpacted the foreign body should be bent so as to bring the point downward, and if the instrumentarium is available probably the costo-phrenic bronchoscope, or pin bending forceps of Jackson, present the best solution to the problem. If these are not available, however, or if the pin is of a type which cannot be bent, the problem of removal point uppermost must be solved.

Unfortunately the lung tissues are not radio-opaque and only delicacy of touch, and the behaviour of the shadow on the screen can guide. The method which was adopted by the writer in both cases was to use the largest size grasping forceps which would enter the bronchiole and to endeavour to grasp the pin as close to the point as possible, and slightly at an angle, so that the sharp end of the pin pointed slightly toward the shaft of the forceps (Fig 2). It was felt that in this way there would be less tendency for the sharp point to catch in the mucous membrane, and this indeed proved to be the case.

The writer has no experience of Tucker's Tack and Pin Forceps, but if these are available they would probably present a better solution to the problem of impaction.

Having established the fact that the foreign body and the forceps were in the same bronchiole, the forceps were turned to grasp anteriorly and were then opened gently and manipulated until one blade of the forceps could be seen on either side of the pin. They were then closed till they almost grasped the pin and withdrawn very gently, the behaviour of the pin being carefully watched. There is no record of the detail of this stage in the first case, but in the second it was found that just before the forceps came level with the point of the pin, the latter flickered suggesting that the point was actually in the mucosa and the movement of the mucous membrane had disturbed it. The forceps were then closed and again rotated to the lateral position, at the same time being pushed slightly forward before being withdrawn. The very gentlest touch is necessary in withdrawal lest the point again become impacted. With the second case this happened on three occasions before the pin was successfully removed.

It was simpler than was anticipated to determine whether lung tissue was being pulled forward or not. The pin was withdrawn about 1 cm the forceps were then opened very slightly, if the point of the pin were impacted and dragging the lung with it, the shadow immediately shot back to its former position. When correctly positioned the forceps could be opened slightly and closed again without movement of the shadow of

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the foreign body, which could then be slowly and gently brought within the bronchoscope.

All forceps likely to be used in the operation must be accurately tested beforehand and tried on a mannikin. So much of the work has to be done by feel that any hesitation in the forceps interferes with the touch. Rehearsal under fluoroscopy on the cadaver lung with the whole team present, including radiologist and Theatre Sister, will more than repay the time spent.

The manipulations are time consuming, and there is no place for speed; twenty minutes is probably the maximum time which could be permitted if damage from X-ray is to be eliminated. If in that time the foreign body has not been removed, the attempt should be abandoned for the time being; moreover the writer's experience would suggest that by the end of twenty minutes both the radiologist and endoscopist are beginning to tire and it is time to stop. It is surprising how tiring the procedure can be—and how refreshing success.

The writer would like to conclude by expressing his thanks to Dr. Walter J. Mowat, his radiological colleague, who co-operated throughout and whose observations are incorporated in this paper.

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THE PRACTICAL APPLICATION OF CLINICAL AUDIOMETRY

By B WARSHAW (London)

Introduction

MUCH misconception exists, particularly in lay circles, as to the nature of audiometric testing and its corollary the selection and subsequent regular use by the patient of a suitable hearing aid. It cannot be too strongly stressed that from the first nervous entry of the patient to the testing room until the final formation of the habit of adjusting and wearing the hearing aid the problem is in very great measure a psychological one.

No greater mistake can be made than to regard audiometric tests as a purely mechanical operation to be performed to a time limit like the taking of a patient's weight or temperature.

In testing the temperature or weight of a patient an instrument of precision is used and itself records the result in a clearly understandable manner without reference to the feelings, opinions or mental condition of the patient. In testing the hearing, however, the instrument used does not itself record any result—it merely produces various standards the effect of which upon himself the patient has to interpret. Hence numerous factors may operate to vitiate the results such as a lack of attention on the part of the patient, his defective powers of concentration, his mental or nervous fatigue, the presence of tinnitus, the audibility of extraneous sounds, and so on. It therefore follows that the obtaining of a true and consistent result depends to a very large extent upon the conditions of test and the technique employed, which must be carefully calculated to produce both suitable and, particularly, consistent conditions during every test. In other words it must be obvious that if the conditions of test vary in method of treatment, procedure adopted, or even location, the results may also vary and thus become unreliable. Too much importance cannot, therefore, be attached to the method of handling the patient and making the test and to the training and personality of the audiometrician if inaccurate or conflicting results are to be avoided.

In the first place the persons to be tested must, if the results are to be of any value, be made to overcome their natural and invariable nervousness and be made to feel "at home". Owing to the class from which hospital patients are mostly derived many are either ignorant, slow to understand instructions or of limited intelligence, and, in particular, entirely unaccustomed to the habit of concentration. Unfortunately these characteristics are in most cases accentuated by the existence of the

very conditions of deafness from which the patient may have been suffering for years. In addition, many patients are "difficult" from sheer prejudice.

Hence the personal element is incalculable and ever changing and requires much time properly to appreciate. For satisfactory results the patient must receive, and realize that he is receiving, individual attention. Hurried treatment will produce entirely unsatisfactory and unreliable conclusions.

The purely mechanical part of the test is thus rendered much more involved by the difficulty of obtaining from the answers given by the patient (which are frequently conflicting) the true facts of the case.

In many cases an immense fund of patience and tact is required in addition to intelligence and technical skill on the part of the audiometrician if a correct and reliable result is to be achieved. No such reliable result can be expected if the patient or the operator, or both, are nervous or flurried or pressed for time. If the tests are carried out to a time schedule (which is no more reasonable than to expect clinical or pathological examinations to be made under similar conditions) the reliability of the results is bound to suffer. Further, it must also be ensured that the whole benefit of the test is not subsequently stultified by the use of an unsuitable hearing aid or the disinclination of the patient to use it, frequently for trivial reasons which can be obviated by a little further sympathetic attention.

A Hospital Audiometric Department

Accommodation. This should include a waiting room, testing rooms or cubicles, a "library" for hearing aids with facilities for fitting and carrying out trials, and an office for the necessary clerical work, records and telephones.

The waiting room does not call for special consideration except that it should be comfortably furnished to allow the patients to relax, contain books for reading, and be close to the other rooms.

The testing rooms or cubicles should be as sound proof as possible in order to eliminate interference between adjoining compartments, from the building generally and above all from outside. They should provide sufficient space for a table to accommodate the necessary apparatus, with a chair for the operator on one side and another seat opposite for the patient undergoing the test. As the patient will require to support an earpiece for some time during the test, the headband often causing discomfort and consequently inattention, it is desirable that sufficient space should be available at the table to allow the patient to use it as a support for his elbow. As the patient is likely to be accompanied by a friend a further seat at or near the table should be provided. It is also desirable to provide, if possible, miniature furniture for the use of small children.

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The lighting should be so arranged as to give sufficient illumination of the dials of the instrument and also of the patient's face so that changes of expression and other indications can be observed without difficulty. This can generally be arranged by having the light behind the operator, though it should not be so placed as to shine in the eyes of the patient.

The "library" or fitting room of hearing aids in addition to providing accommodation for the appliances and facilities for making the impressions for the ear moulds (which will require a supply of hot water) should reproduce as far as possible ordinary conditions. Thus it should be possible to hold conversations with a patient at normal distances while the reasonable sounds of life are not excluded. The fittings should include a display cabinet for the sets (both electrical and non electrical aids) and such ordinary furnishings as will permit the patient to relax and converse in comfort.

The work involves the keeping of a considerable quantity of records and correspondence and therefore proper office accommodation is required.

Equipment As the Pure Tone Audiometer is of comparatively recent development and the whole structure of clinical audiometry may be said to be based upon it, a brief enumeration of the features which should be incorporated in an up to date and efficient instrument may not be out of place.

There should be an absence of background hum in operation and there should be clear and direct reading dials preferably placed in an upright or sloping front or otherwise so arranged that it may be possible to see the instrument face from a seated position without having to stand up or adopt a crouching attitude. The controls should be arranged so that they may be manipulated for long periods without unduly tiring the operator and without involving movements which can be detected by the patient and a pilot light or illuminated dials should indicate when the current is on.

The fittings must include air and masking receivers and a bone conductor of ample area designed to avoid causing pain when pressed against the mastoid bone. For clinical audiometry a sliding frequency known as a "sweep" frequency, throughout the entire range of audible sounds is preferable to a fixed frequency producing octaves or semi octaves only, though these may be sufficient for carrying out tests for hearing aid purposes. If a sweep frequency is provided some visible means of checking the pitch (e.g. a cathode ray tube) and a tuning device for correcting it as the machine warms up in use should also be included. Automatic and manually operated interrupter switches should be available in order that the sound may be made intermittent or rhythmical as well as continuous. Such switches should operate noiselessly. It should be possible to produce a masking tone and to vary its volume and pitch. It should also be possible to switch the masking tone and the frequency notes from one earphone to the other to obviate removal and reversal of

B. Warshaw

register and work up and down from it. Only when two or three consecutive answers agree is the response accepted and noted on the chart. The next test note is then given loudly and the procedure repeated. Care must be taken not to give the note with a degree of loudness sufficient to cause pain or discomfort. It is necessary between each change of note, or at frequent intervals, to allow a rest period of several seconds in order to avoid fatigue of the auditory nerve and allow the patient to regain his normal standard of hearing. Owing to the difficulty of maintaining the attention of the patient and his power of recognition of sounds it is essential frequently to change the nature of the test note from a sustained to a fluctuating or intermittent sound. The accuracy of the patient's answers may be checked to some extent by varying the length of the note and interruptions given. As the patient is apt to anticipate the required answers by observing the movements of the operator it is essential that the manipulations of the instrument and the reading of the dials should be carried out without visible movement. It is also essential that the patient should be constantly observed for flickering of the eyelids or other revealing reflexes which may be at variance with his answers, and the operator should not therefore keep her eyes fixed on the dials.

The audiometrician must be able to detect nerve fatigue, "echo" and distortion of various kinds, warning the patient not to confuse the test sounds with his own tinnitus, and at the same time to be alert to the possibility of such confusion. Where patients are suffering from tinnitus it is necessary to employ intermittent or rhythmical sounds to differentiate the test tone. In cases of nerve fatigue the sound cannot be held for more than a few seconds and an intermittent note should be used and progressively decreased in volume upon each repetition. When the threshold of hearing for that note is found the patient is asked to signify the commencement and cessation of his hearing of it in order that the duration of hearing may be noted on the chart. When the sound seems to be continued after it has in fact ceased the patient is asked to indicate when the note is no longer heard, so that the period between the cutting off of the sound and its loss to the patient may be marked on the chart. If the tinnitus takes the form of a pure note or notes the frequency and volume of the sounds have to be ascertained by means of trial and error in comparison with the audiometer, the actual point or points of tinnitus being noted on the chart. Frequent enquiry must be made of the patient as to the exact nature of the sounds heard as these may consist of certain distortions such as a series of little notes, a "warbling" note, or even double notes, in place of the sustained tone given by the audiometer. Again, a rising scale on the audiometer may be heard by the patient as a descending scale, and it is frequently found that high notes are heard as "crackles" only, or as a "crackle" when soft changing to a pure note when loud. Some patients suffering from certain illnesses or depression

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fail initially to hear the notes given and in such cases it may be necessary to produce a loud note with sufficient suddenness to force recognition and so provide a foundation note from which to proceed

The whole of the foregoing procedure must be carried out for each ear

If the tests on the two ears produce a graph with parallel curves 30-40 decibels apart it is possible that the sound has lateralized from the bad to the good ear and the test on the bad ear must be repeated with a masking tone on the good ear

In testing for bone conduction the same procedure will require to be adopted but with various modifications. The bone conductor has to be pressed tightly against the mastoid bone in a position giving the maximum sound (which must be found by trial), and an earphone so adjusted as to produce a masking hum should be worn over the ear not under test to prevent the patient answering to a lateralized sound. Sounds usually lateralize more easily in bone conduction than in air conduction. When a patient has a middle-ear deafness the bone conduction is usually increased hence the wrong technique of using two earphones for masking (the masking tone being switched from one ear to the other) creates an artificial middle-ear deafness in the ear being bone-tested and an apparent increase in the bone conduction

A lateralization test should be carried out at the end of every audiometric examination. The bone conductor should be placed at midline on the forehead and the various frequencies be applied with reasonable volume. The notes will be heard either 'somewhere in the middle' or in one or both ears, and this information is noted on the chart

Should a hearing aid be prescribed by the otologist a speech intelligibility test should be carried out for which purpose it will first be necessary to balance the reception of sound by both ears the threshold of hearing then being ascertained for a normal speech frequency and approximately 50 decibels (volume) being added. Each ear should then be tested independently by ordinary speech through the microphone or by means of specially prepared gramophone records for the purpose of ascertaining upon which ear the hearing aid receiver should be worn. It may be noted that the ear which hears the most sound may not, owing to various distortions, have the clarity of reception possessed by the other ear which latter will therefore be the better suited for use with the hearing aid

Special tests are required for the detection of malingering of which the following are examples —

- 1 Various audiometric tests carried out at intervals of days should be consistent to within about 5 decibels and if the results show considerable variation it is probable that incorrect answers are being given
- 2 A case of pronounced unilateral deafness should produce a graph with two parallel curves having about 40 decibels difference. If

that the earpiece should fit tightly on or into the ear or on the mastoid bone to prevent "feed back". Under no circumstances must the volume be switched on before the earpiece has been fitted, and the volume must be switched off before the earpiece has been removed. The patient is shown how to adjust the amplification. The first fifteen minutes are taken up in allowing the patient's ears to focus and in teaching him to put all extraneous sounds into the background. Initial confusion will soon give way to the ability to distinguish sounds more clearly, this ability being tested by putting to the patient questions containing words which are unexpected, the answers to which will indicate to the audiometrician further adjustments which the set may require.

If the hearing aid is to prove satisfactory the patient must be instructed as to various technical points on its use and maintenance. The volume must not be so great as to cause headaches, nerve fatigue, irritability and distortion of sounds, neither must it be so small as to cause strain and bad temper. Information should also be given as to the use, rotation and replacement of batteries in order to obtain the longest "life" from them.

Although the problem of comfort in wearing the instrument may appear to be of slight importance to those with normal hearing, it has in fact an immense psychological significance, its solution being of practical help to the deaf. A manual worker, for instance, must be shown how to dispose of the set so that the conditions of his work will not harm the instrument. Much irritation and annoyance can be caused by constantly catching the hands in the loose wires and pulling out the delicate plugs, and in time causing the wires to wear and break. Considerable care must therefore be taken to ensure that the microphone and valves are worn in such places as to avoid risk of mechanical damage, and that loose wires are concealed under jackets, blouses, etc. The batteries must not be worn in such a position as to become damp from perspiration. In the majority of cases it is possible so to arrange the hearing aid that only the earpiece and the wire leading to it are visible.

In the case of school children an accumulator box-type set for standing on the desk is usually found to be most suitable and its use entails the giving of directions to the headmaster or headmistress so that it may be kept in safe custody and be placed on trickle-charge at nights.

Many of the deaf cannot obtain intelligibility from an electrical hearing aid and many are not sufficiently deaf to require one, in which cases a non-electrical instrument should be fitted and tested. The commonest types comprise auricles (single or double) speaking tubes, trumpets, ear shells, and banjo, bell, swan and cup shapes.

The level of ordinary intelligence in the patient may not be of the highest and this, coupled with much ingrained prejudice and the condition of introversion so often associated with deafness, may make it most difficult to produce a satisfied state of mind, and the finding and

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that no visible indication is given) and to watch closely for any reflex motions. The successful carrying out of such a test usually necessitates a number of attendances before the confidence of the child can be obtained sufficiently to produce satisfactory results.

Technique of Fitting Hearing Aids

Should the doctor's instructions require the supply of a hearing aid it is, of course, possible to supply a standard pattern such as that adopted by the Ministry of Health and consider the matter satisfactorily closed. Years of experience indicate, however, that no one hearing aid will suit all types of deafness and more satisfactory results may be expected if the matter is taken a good deal further, inasmuch as types of deafness and makes of hearing aids differ considerably, and must, if satisfactory results are to be obtained, be brought into agreement.

Selection of hearing aid. The selection of a suitable hearing aid obviously cannot be left solely to the patient and only those aids which are considered suitable should be submitted for fitting. In the selection numerous points arise of which the following are the most important —

- (a) *Degree of deafness.* A decision can be made as to the suitability of an air or bone conduction instrument by a study of the audiogram.
- (b) *Purpose for which required.* The type of set may be modified by the conditions under which the patient requires to use it, as, for example, ordinary conversation, listening to lectures, school, and so on.
- (c) *General appearance or design.* As it is impossible entirely to conceal the set about the person in all circumstances, the smallest and most inconspicuous or alternatively the one of the best appearance, is most often chosen.

Fitting of hearing aid. Most modern electrical hearing aids can be adjusted to intensify low, middle or high frequencies, and many makes have different adjustments of earpieces for greater selectivity of sound. It is therefore necessary to adjust the set carefully from the chart with these points in mind before the patient first tries it. Numerous further adjustments will then need to be made by a process of trial and error.

The foregoing procedure will have to be repeated on several sets so that the patient may make a selection. Throughout these tests it is essential that the patient should not be able to see the audiometrician's mouth in order that answers shall not be given based on lip reading instead of hearing.

The earpiece, whether disc, anatomical mould or bone conductor, will whistle if uncovered or fitting loosely when the volume is first switched on, and should it be in close proximity to the ear when this oscillation occurs will cause great distress and sometimes pain. It is essential, therefore,

that the earpiece should fit tightly on or into the ear or on the mastoid bone to prevent "feed back". Under no circumstances must the volume be switched on before the earpiece has been fitted, and the volume must be switched off before the earpiece has been removed. The patient is shown how to adjust the amplification. The first fifteen minutes are taken up in allowing the patient's ears to focus and in teaching him to put all extraneous sounds into the background. Initial confusion will soon give way to the ability to distinguish sounds more clearly, this ability being tested by putting to the patient questions containing words which are unexpected, the answers to which will indicate to the audiometrician further adjustments which the set may require.

If the hearing aid is to prove satisfactory the patient must be instructed as to various technical points on its use and maintenance. The volume must not be so great as to cause headaches, nerve fatigue, irritability and distortion of sounds, neither must it be so small as to cause strain and bad temper. Information should also be given as to the use, rotation and replacement of batteries in order to obtain the longest "life" from them.

Although the problem of comfort in wearing the instrument may appear to be of slight importance to those with normal hearing, it has in fact an immense psychological significance, its solution being of practical help to the deaf. A manual worker, for instance, must be shown how to dispose of the set so that the conditions of his work will not harm the instrument. Much irritation and annoyance can be caused by constantly catching the hands in the loose wires and pulling out the delicate plugs, and in time causing the wires to wear and break. Considerable care must therefore be taken to ensure that the microphone and valves are worn in such places as to avoid risk of mechanical damage, and that loose wires are concealed under jackets, blouses, etc. The batteries must not be worn in such a position as to become damp from perspiration. In the majority of cases it is possible so to arrange the hearing aid that only the earpiece and the wire leading to it are visible.

In the case of school children an accumulator box-type set for standing on the desk is usually found to be most suitable and its use entails the giving of directions to the headmaster or headmistress so that it may be kept in safe custody and be placed on trickle-charge at nights.

Many of the deaf cannot obtain intelligibility from an electrical hearing aid and many are not sufficiently deaf to require one, in which cases a non-electrical instrument should be fitted and tested. The commonest types comprise auricles (single or double) speaking tubes, trumpets, ear shells, and banjo, bell, swan and cup shapes.

The level of ordinary intelligence in the patient may not be of the highest and this, coupled with much ingrained prejudice and the condition of introversion so often associated with deafness, may make it most difficult to produce a satisfied state of mind, and the finding and

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fitting of a suitable hearing aid is generally found to take a considerable time and much patience

In appropriate cases the patient should be recommended to purchase and use special gramophone records which produce simple and complex sounds at varying intensities and which will enable him to regain recognition of sounds which he had formerly failed to identify. All patients should be recommended to take up the study of lip reading, which forms a most useful adjunct to their hearing aids

The instrument finally selected should be taken by the patient for a week's trial under the conditions in which it is to be used. At the end of the week the patient should again be seen by the audiometrician when any necessary further adjustments may be made or advice be given. Many of the patient's difficulties are often found, however, to be more psychological than mechanical. If necessary further tests should be made with a view to the selection of another set. When the patient is fully satisfied that the instrument he has had on trial is the best one for him and is prepared to keep it, arrangements may be made for him to keep it if a Government instrument, or to purchase it on special terms through the hospital. A wax impression of the ear should then be prepared for those desiring an anatomical moulded ear-piece. It is desirable for patients to deal only with the manufacturers of the sets should any mechanical defect appear.

If the patient is invited every three months to attend for re-test of his hearing and for any other assistance required not only may further help be given but much valuable research data may be obtained.

To furnish a hearing aid set 'of sorts' without regard to its suitability for the particular case is to copy the methods of some commercial salesmen and thus possibly leave the patient as deaf with the hearing aid as he was without it. Further, to send him off with any set, however suitable, and to take no further steps to ensure its efficient functioning is equivalent to handing him a Proetz Displacement Set or a Higginson's syringe without explanation and expecting him to discover for himself its proper use.

Owing to the infinite variety of patients treated their differing ages, their kinds and degrees of deafness and the varying standards of intelligence and willingness to co-operate detailed procedure must of necessity vary and depend to a large extent on the patient and the ability, individuality and tact of the operator. Hence the foregoing must be regarded only as providing a general indication of procedure which may have to be varied considerably or repeated in accordance with the requirements of each individual patient.

The Taking of Wax Impressions for Moulded Earpieces

The accepted idea of a hearing aid has for many years been some more or less conspicuous appliance actually applied over the ear, the ordinary disc earphone familiar in early radio sets being typical. A perhaps natural

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prejudice against wearing this obvious indication of deafness has existed and has proved in very many instances a serious drawback to the use of a hearing aid. There is now available, however, a fitting which can be applied most inconspicuously to the ear, viz., the anatomical moulded earpiece of plastic material. While this is not in actual fact so efficient as a disc earphone its adoption has done much to help the deaf by making almost unnoticeable any outward indication of the disability from which they suffer. It should therefore become a regular part of the duties of the audiometrician to take impressions of the patients' ears from which a technician can produce in plastic material a permanent, well-fitting and almost invisible earpiece.

While standard earmoulds of various sizes and designs are commercially available many of these fail properly to fit the user's ear. They frequently drop out and cause considerable annoyance to the wearer and may possibly give rise to "feed-back" as already mentioned. Again if the contour of the ear does not correspond with the standard design friction or pressure may cause soreness, possibly aggravated by the presence of perspiration. A properly fitting earpiece is therefore essential if comfort combined with the maximum benefit is to be obtained from the hearing aid. Such earpieces may be specially made from individual wax impressions, the efficient preparation of which demands both skill and experience.

Several methods of taking the necessary impression of the ear exist and the following has been proved to be both safe and simple as well as efficient.

Technique. A little cotton wool should be twisted on to the end of a wooden applicator, dipped well into vaseline and applied to the ear, which should be greased along and around the meatus, over the concha and the inner part of the auricle, going particularly well into the triangular fossa and under the front of the helix. Too much grease cannot be applied and too little can be harmful as it may allow hairs to stick to the wax, resulting in pain to the patient and possibly septic spots if the hairs are pulled out on removing the wax. Special note should be taken of the size and direction of the canal while greasing the ear.

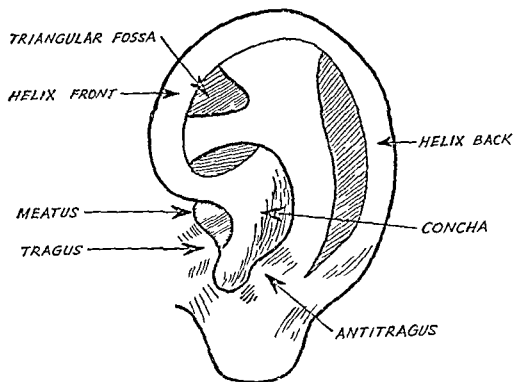
Experience will soon indicate the quantity of wax required and this should be melted in hot water until very soft and pliable. It should then be lifted out with a metal instrument and moulded by folding over and over, making a small tapered point at one end. This point should be small enough to push into the canal into which it should not extend more than about a quarter-of-an-inch. The temperature of the wax should be tested by placing it on the back of the hand and if it is too hot for this position it is too hot for the patient's ear, to which, however, it will not be sufficiently pliable to mould if it is too cool.

The insertion of the wax into the canal will press air forward against

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the drum so that the patient should keep his mouth open while the wax is gently pushed in the direction of the meatus and moulded with the probe well into the triangular fossa and under the front of the helix. It may be noted that the patient's mouth should only be opened slightly, otherwise the shape of the ear may be modified. Particular attention should be given to that portion of the impression under the helix as it will be this part of the mould which keeps the earpiece in place. The wax should be pushed behind the tragus making sure that it is not bulged by too much wax behind it and also behind the antitragus, care being taken that neither are folded over into the wax. Finally the wax should be pressed with the fingers in the direction of the canal and concha so as to cover the ear but leaving a depression in the centre so that the ear may be able to recover its normal position.

The wax should be cool in a few minutes and may then be removed by twisting the top of the impression in a direction away from the face. Surplus vaseline may then be removed from the ear with a piece of cotton wool and the whole procedure should not have taken longer than fifteen minutes. The wax impression is then sent to a technician who will reproduce from it a well-fitting, comfortable and inconspicuous moulded plastic earpiece.



Conclusion

The practical side of clinical audiometry and the fitting of hearing aids has been dealt with above in some detail but no standard of technique and mechanical efficiency, however high, can by itself ensure success. It cannot, therefore, be too strongly emphasized that the human element

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must receive as much, or more, consideration than the mechanical. The application of audiometrics and the fitting of hearing aids cannot be properly carried out by an untrained person or one of unsuitable personality. The possession of somewhat exceptional abilities is required in addition to tact, patience and willingness to take endless trouble. In addition, for the really successful audiometrician a sound training in the following branches of the subject is essential, namely, the psychology of the deaf, the handling of deaf-mute children, the rudiments of lip-reading, the anatomy, physiology and diseases of the ear, including the causes of deafness and the medical terminology involved, the basic principles of acoustics of the ear, the physics of audiometers and hearing aids and their adjustment, medical and professional etiquette and hospital practice. Only on such lines can an organization of real and lasting benefit to the deaf be constituted. A trained audiometrician having the abilities outlined above should not, of course, be confused with a technician whose main function it is to carry out purely mechanical repairs and adjustments to hearing aids.

Evidence goes to show that even with the most painstaking and careful attention to the selection of suitable appliances followed by instruction and help in their use only about 66 per cent. of the instruments are finally retained by the patients. The aim of modern audiometry should be to make hearing aids 100 per cent. successful.

THE EFFECTS OF STREPTOMYCIN ON THE EIGHTH NERVE SYSTEM*

By M R DIX (London)

SINCE streptomycin was discovered to be effective against tuberculosis in guinea pigs (Feldman and Hinshaw, 1944), there have been reports of increasing and successful use of the drug in the treatment of the disease in man

Almost all who have used streptomycin over long periods have at the same time observed certain toxic effects in the patients treated. The first specialized report of the aural complications was made by Brown and Hinshaw (1946). Vestibular disturbances such as light-headedness, dizziness and giddiness of varying intensity were the most common symptoms described, and a gradual decrease in labyrinth function was demonstrated by means of caloric and turning tests. Cochlear disturbances were much less common. The complaint was of deafness and roaring tinnitus. This occurred in patients receiving large doses of streptomycin (3 to 10 gm daily). In no case in which the patient received 1 to 2 gm streptomycin daily did disturbances of hearing occur. Hearing returned in two cases on discontinuing the drug.

A detailed investigation of the effects of streptomycin on the labyrinth has recently been made by Glorig and Fowler (1947). In over 90 cases seen by these observers there were only eleven cases of deafness, and among these only three were not associated with meningitis which could not be excluded as the causal agent. Vestibular disturbances were, on the other hand, very common. In a series of twenty-three cases whose vestibular function was very carefully studied there was loss of response to rotation and caloric stimulation in twenty after twenty-five days of treatment. No recovery of vestibular function was reported after four months from the first negative caloric response. None of these patients received more than 2 gm of streptomycin daily.

From the above results, it would appear that streptomycin has a selective toxic effect upon the VIIIth nerve system. Toxic vestibular effects are the rule in cases receiving a dosage of not less than 30 mg streptomycin per kg body weight. Cochlear effects are very much less common and are unlikely to occur unless the drug is given in larger doses.

* From the Otological Research Unit, Medical Research Council National Hospital, Queen Square, London.

We have recently had the opportunity of observing the effects of streptomycin on six patients treated at the National Hospital. Five of these patients were children and the drug was given for tuberculous meningitis. The other patient, an adult, received a prophylactic course of streptomycin after the excision of a parietal tuberculoma. The present note is a record of our observations of VIIIth nerve function.

The streptomycin used for this investigation was made by Merck & Co. and had potencies of 600 to 650 micrograms streptomycin per milligram solid. The concentration of the drug aimed at was 0.02 gm. per lb. of body weight (44 mg. per kg.). This was given by six-hourly intramuscular injections.

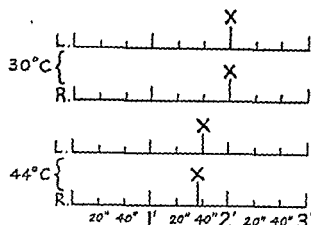
The first four children treated received the course recommended by the Medical Research Council to extend over a period of three months. Three of these received 0.1 gm. streptomycin daily by intrathecal injections during the first and third months in addition to the intramuscular injections. The fourth child received intrathecal streptomycin during a second course after two months' rest from all treatment. In the case of the fifth child, the first course of intramuscular streptomycin was prolonged for five months. The adult patient received prophylactic streptomycin over a period of six weeks.

Effects of streptomycin on the VIIIth nerve system were observed at intervals throughout the period of treatment in each case.

Vestibular effects were measured by means of the caloric test, as described by Fitzgerald and Hallpike (1942). A two-pint metal douche can was filled with water and the temperature adjusted first to 30° C. and then 44° C., temperatures 7° C. above and below body temperature. The water level was some two feet above the ear to be tested. Water from the can reached the ear by means of rubber tubing connected to a nozzle tip 4 mm. in diameter, inserted in the external auditory meatus. The patient lay in the dorsal position for the test with the head raised 30° above the horizontal and fixed his gaze on some convenient point on the ceiling in the centre of his field. Each ear was irrigated with water at both temperatures for a period of 40 seconds measured by a stop watch, precautions being taken that the minimum volume of water reaching the ear during this time was not less than 8 fluid ounces. Reaction duration was measured from the beginning of the irrigation to the point of disappearance of the nystagmus. If no nystagmus was observed at these temperatures the ear was further irrigated for 60 seconds with colder water, at about 22° C. Only when no response was observed under these conditions was the caloric reaction said to be absent.

The results have been recorded graphically as shown in the accompanying chart which depicts a normal reaction pattern. Each line represents a three minute interval. In each case the end-point of the nystagmus is denoted by a cross.

Effects of Streptomycin on Eighth Nerve System



Cochlear function was difficult to investigate at the first examination in the case of the children as they were drowsy, ill and unable to co-operate. As their general condition improved, however, we were able to obtain satisfactory responses to whisper tests in all and pure tone audiograms in four cases.

Results

The effects of streptomycin upon the VIIIth nerve system and general clinical condition of the six patients are shown diagrammatically in the figures which follow. The total daily dosage of streptomycin per kg. of body weight is based upon the average body weight over the period of treatment. The results may be summarized as follows :—

Cochlear function. In one only of six cases was cochlear function significantly reduced during the course of streptomycin treatment.

Vestibular function. The caloric responses were abolished in all six cases in the course of treatment. This occurred whether streptomycin was given by intramuscular injection only or by combined intramuscular and intrathecal routes.

Comments

In the case of the five children there was no subjective vestibular disturbance throughout the initial course of streptomycin therapy, and no spontaneous nystagmus was observed. In the case of the adult, on the other hand, subjective vestibular disturbances were a marked feature. Severe vertigo and nausea were experienced for several days some three weeks from the onset of streptomycin therapy. These symptoms resolved as the caloric responses were abolished. He has regained his balance slowly but still has some difficulty in walking in the dark after nine months.

In five of the cases described caloric responses were completely and permanently abolished during the first course of streptomycin therapy. In the sixth case (K.M.) although caloric responses were reduced during his first course of treatment they were never completely abolished. After two months' rest the responses were partially restored. They only disappeared completely during a second course of treatment.

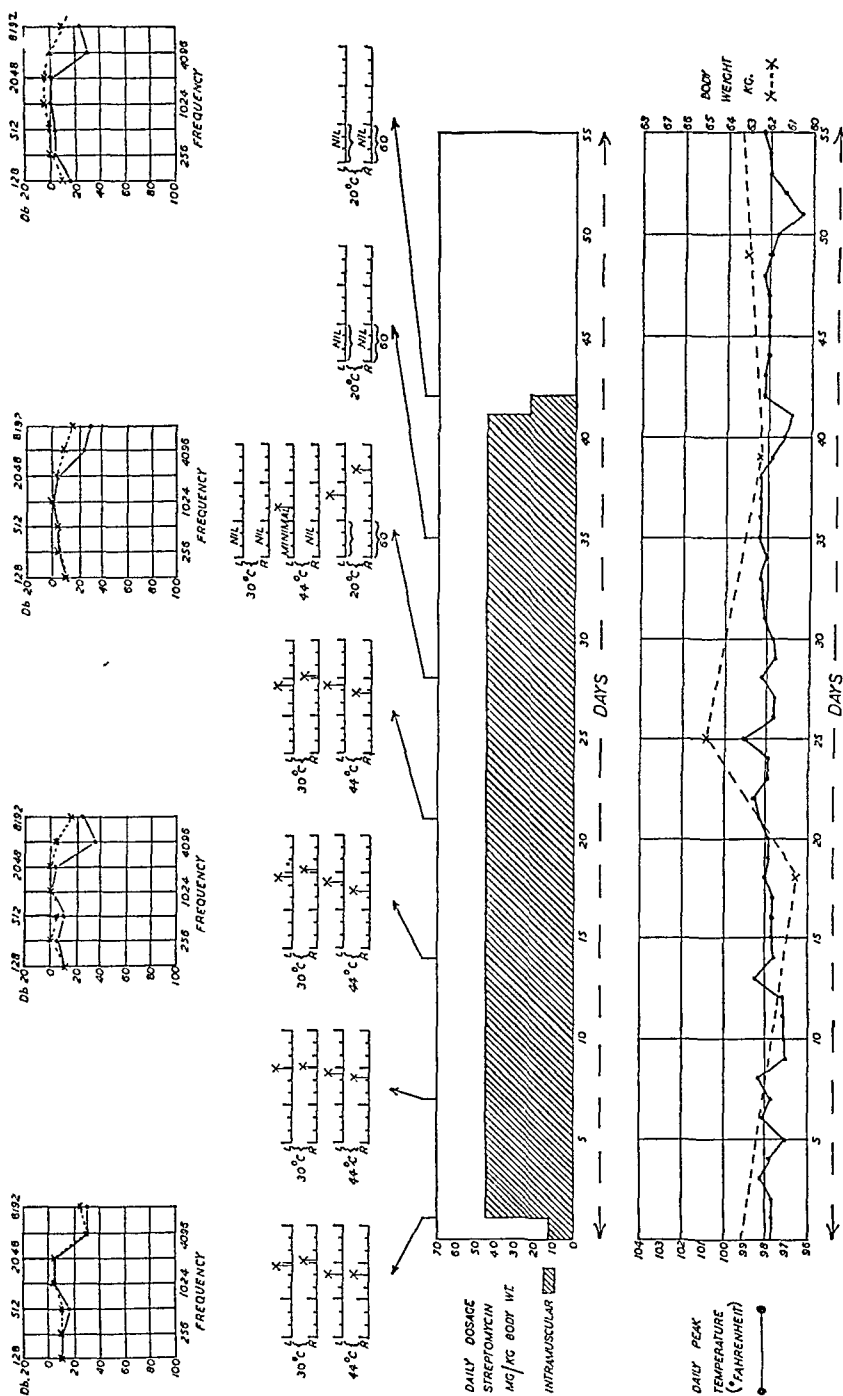


FIG. 1.

Case History: A.B., aged 40 years. Tuberculoma R. parietal region excised twelve days ago. Admitted for prophylactic streptomycin. Examination: weakness and some cortical sensory loss L. arm and leg. Improving. Progress and Treatment: intramuscular streptomycin 42 days. Twenty-third day: complaint of "nodding sensation". Twenty-fifth day: nausea and dizziness. Unable to sit up unaided. Slight first degree nystagmus to R. Thirty-second day: vestibular symptoms less marked. No spontaneous nystagmus. Condition continued to improve eight months when signs of pyramidal disease and slight R. cortical sensory disturbance noted. There was no return of caloric responses. Improving again after second course streptomycin.

Effects of Streptomycin on Eighth Nerve System

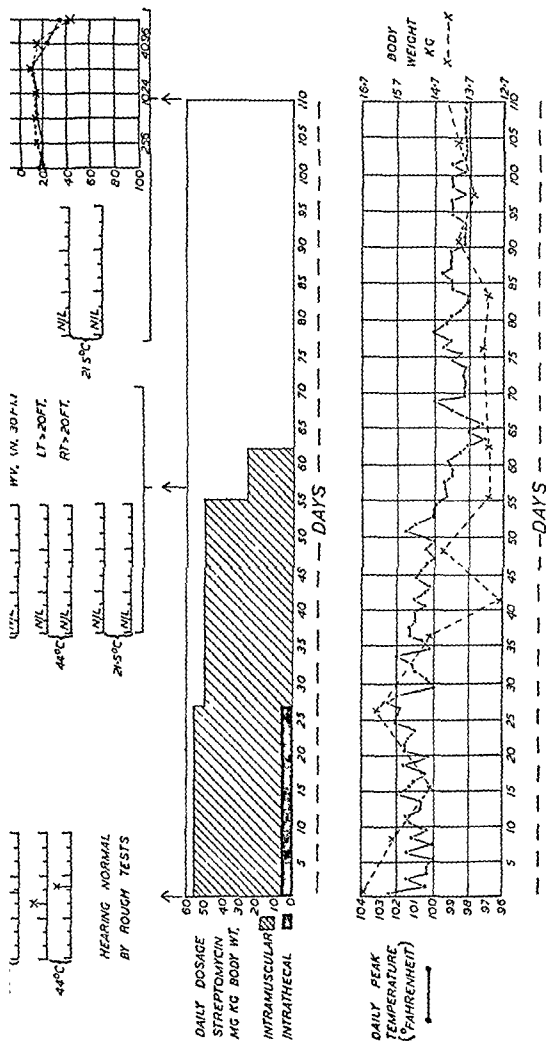


Fig 2

Case History T W aged 6 years Headache four weeks Ailing four months
Examination Well-nourished drowsy child Kernig's sign + ve Slight bilateral papilloedema Cerebrospinal fluid T B present.
Pressure 300 mg Hg X-ray lungs clear
Progress and Treatment three months course streptomycin begun Intrathecal administration discontinued twenty-seventh day
owing development persistent vomiting Child relapsed and died later
Autopsy internal hydrocephalus owing block at exit from fourth ventricle

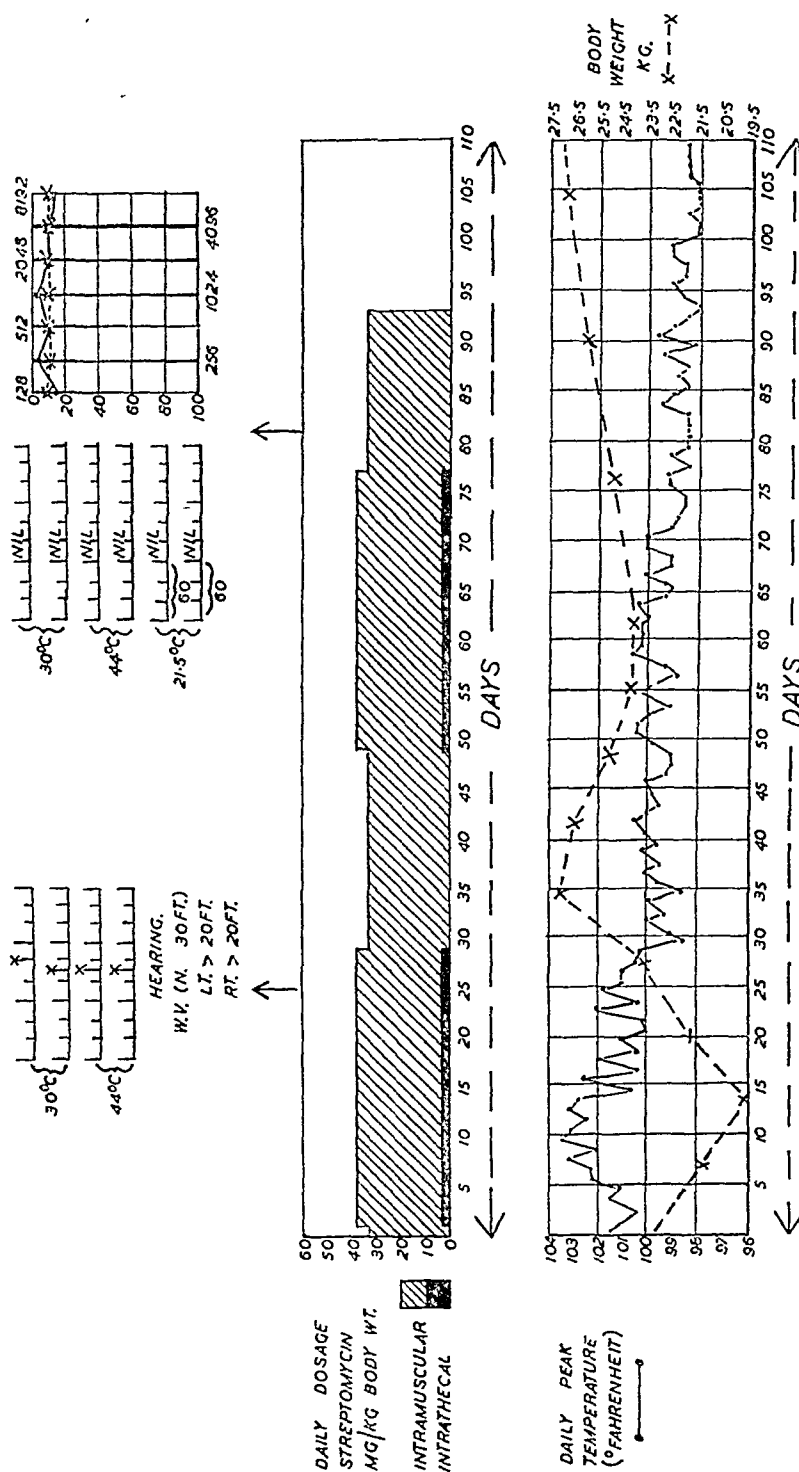


Fig. 3.

Case History : B.E., aged 7 years Headaches four weeks. Chronic L. internal strabismus. Mother in sanatorium three months following hemoptysis seventeen years ago.

Examination : mild neck rigidity. Kernig's sign + ve. M.T.s intact, dull. Cerebrospinal fluid : T.B. present. X-ray : extensive tuberculosis upper lobes both lungs. Progress and Treatment : full course intramuscular and intrathecal streptomycin with steady improvement in general condition. After three months X-rays showed marked improvement in L. lung condition and R. upper lobe primary focus resolving. Child relapsed after cessation of treatment but is improving steadily with second course streptomycin.

Effects of Streptomycin on Eighth Nerve System

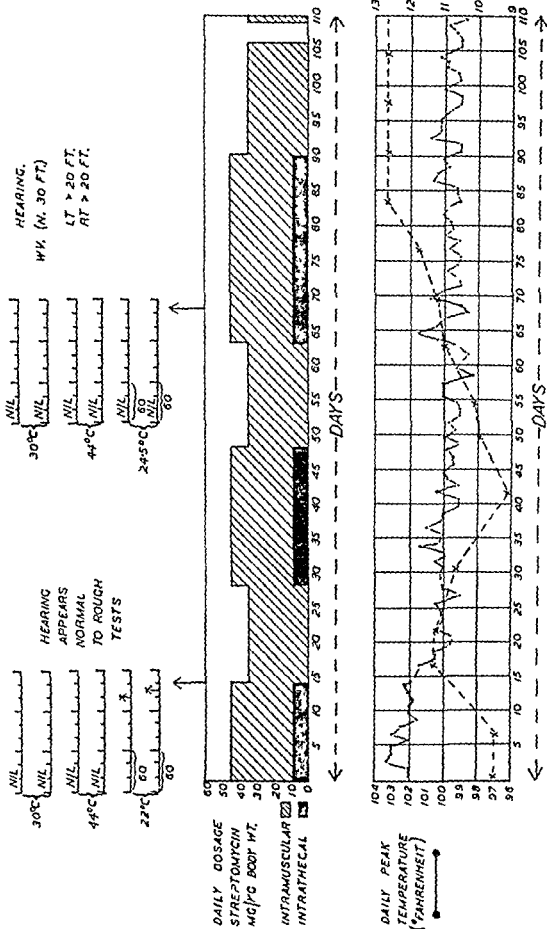


Fig. 4

Case History P L, aged 5 years Headache Ailing since measles three months ago

Examination very undersized child Kernig's sign + ve R plantar extensor

present X-rays milary tuberculosis both lungs

Progress and treatment course 3 months intramuscular and intrathecal streptomycin begun. Intrathecal course interrupted owing

abscess over lumbar spine fourteenth to twenty-eighth day Subsequent progress very satisfactory until 101st day X-rays showed lung

fields completely clear After this relapsed and died

Autopsy internal hydrocephalus owing block around foramina of Lushka

Cerebrospinal fluid TB

Clubbing fingers

Intrathecal streptomycin begun.

Intrathecal course interrupted owing

abscess over lumbar spine fourteenth to twenty-eighth day

Subsequent progress very satisfactory until 101st day

X-rays showed lung

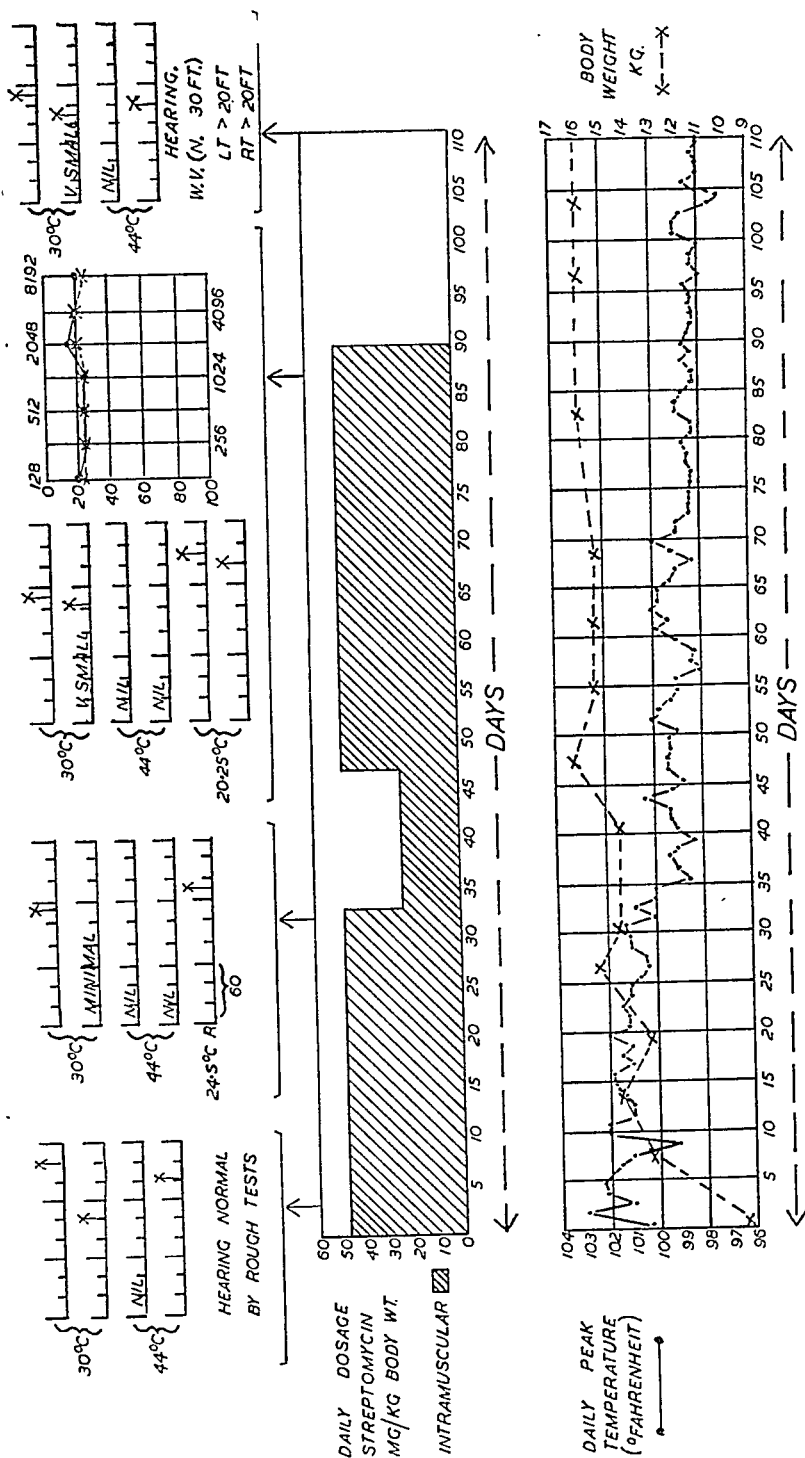


FIG. 5.

Case History : K.M. aged 5 years. Headache and anorexia four weeks. Mother has open pulmonary tuberculosis, sleeping with child. Examination : pale drowsy child. Slight neck rigidity. L. plantar extensor. Cerebrospinal fluid : T.B. cultured. X-rays lungs : pleural effusion R. base. R. lower lobe lesion.

Progress and Treatment : three months course intramuscular streptomycin begun. Urticarial rash and vomiting after ten days but injections continued until thirty-third day when dosage halved owing albuminuria. Symptoms cleared by forty-seventh day when full dosage given remainder of course.

Effects of Streptomycin on Eighth Nerve System

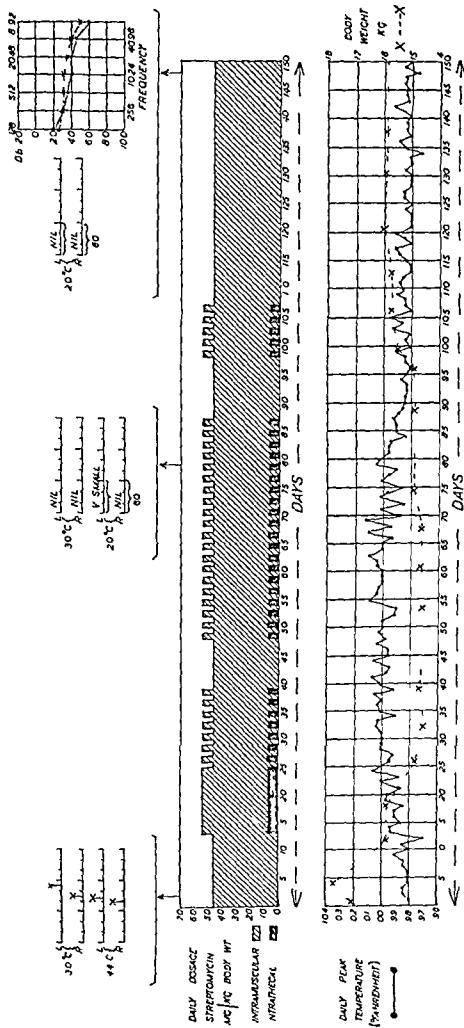
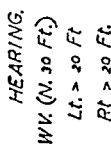


FIG 6

Case History K M aged 5 years (continued) After two months rest from treatment general condition had deteriorated Vomited repeatedly During second course streptomycin (above) has improved and apart from general apathy and occasional tendency to vomit there is no clinical evidence of hydrocephalus



Case History : M.B. aged 3 years. Measles nine months ago. Pertussis six months ago. Ailing with dry cough since. Anorexia and sweating one month. Vomited two weeks ago. Spindle-shaped swelling R. index two weeks. F.H. : tuberculosis. Examination : R. extensor plantar. Spindle-shaped swelling R. index, no X-ray changes. X-ray lungs : miliary tuberculosis. Acid fast bacilli stomach and stools, Cerebrospinal fluid : T.B. cultured.

Progress and Treatment: intramuscular course streptomycin 150 days. Dose reduced when admitted National Hospital tenth day. After subsequent thirteen days rest developed vomiting and pyrexia. Improvement with second course intrathecal and intramuscular streptomycin. Lungs now clear and condition satisfactory apart from osteochondritis R. scapoid. Still continuing intramuscular streptomycin after five months.

Effects of Streptomycin on Eighth Nerve System

There has been no sign of re-appearance of caloric responses after their complete abolition in any case. In Case I (A.B.) caloric responses were still completely absent eight months after cessation of streptomycin therapy.

There has been no subjective cochlear disturbance in any case. The only case showing any objective disturbance was K.M. in which the audiogram showed some loss of hearing towards the end of the second course of streptomycin. More recent audiograms after three weeks' rest indicate that the hearing is again improving.

Summary

The observations recorded confirm the results of Brown and Hinshaw, (1946), Fowler and Seligman (1947), Glorig and Fowler (1947), that streptomycin has a selective toxic action upon the vestibular apparatus. The precise locus of this action remains obscure.

Acknowledgements

All of the six patients described in this paper were under the care of Dr. E. A. Carmichael, Director of the Neurological Research Unit, Medical Research Council, to whom grateful acknowledgements are due.

Thanks are also due to Dr. E. P. Morley and Dr. R. E. Kelly for their kind help and criticism in preparing the case histories

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HEAD NOISES OF MUSCULAR ORIGIN*

AUDIBLE OR OBJECTIVE TINNITUS

By HUGH W. SCHWARTZ (Halifax, Nova Scotia, Canada)

A MALE, aged 32, was admitted to the Medical Service of the Victoria General Hospital, under Dr. K. A. MacKenzie, July 13th, 1945, complaining of headaches and a sound like "the tick of an alarm clock" in both ears. Although the patient had noticed the "tick" on and off for three years, lasting for periods of days or weeks, it had not caused him actual annoyance until three months before admittance. The "tick" did not interfere with sleep unless an ear was on the pillow. In the presence of noise, and as an operator of a compressed air drill, he claimed he suffered a great deal of distress from the headaches.

The observations made at this time were that a bilateral clicking-grating like noise, 108 per minute (my own note was 78), easily audible at a distance of two or more feet from either ear. Up and down movements of the tongue and soft palate were noted as well as rhythmical contractions of the masseter and temporalis muscles on clenching the jaws; all were in time with the clicking noise. The rate could not be influenced by activity and was unrelated to the pulse.

No movement of the ear-drums could be detected. He was able to chew, bite, swallow and extend the tongue normally. My interne was assigned the special duty of making observations when the patient was sleeping and reported that the ticking did not cease. On the whole it was felt that the impulse, whatever its origin, was distributed for the most part by the motor division of the Vth nerve and we were thinking in terms of a growth. (As to the tick itself it was thought that probably the tensor tympani might be the explanation.) One of those interested remembered seeing a case when in London of a young girl with rhythmical contractions of one side of the tongue leading to hypertrophy of that organ which was believed to be secondary to an encephalitis.

The patient realizing that he was more or less of a curiosity and that none of the physicians were any too well informed about the matter departed for his home before we had time to consult the journals. The textbooks made no mention of the condition.

Two months later, September 10th, he was admitted to the Montreal Neurological Institute and Dr. MacKenzie was sent the following report :

* Delivered before the Canadian Oto-laryngological Society, June 23rd, 1947.

Head Noises of Muscular Origin

Objective Findings on Physical Examination

- 1 On auscultation over the head, there is a rhythmic noise about 87/sec
- 2 Rhythmic contraction of temporal and masseter muscles with gnitting of teeth
- 3 Rhythmic contraction of orbicularis oculi when eyes are shut
- 4 Rhythmic movements of palate and tongue when the mouth is open

Laboratory Data

Consultation with Dr McNally, September 11th "Nasopharynx. Both eustachian tube orifices are open. There is a continuous tremor-like movement of the anterior wall of the eustachian orifices, which is made up chiefly of the levator palati muscles. This tremor or spontaneous movement appears to extend into the soft palate and the movement of the soft palate consists in a constriction with an elevation just over the base of the uvula, which can be seen with the nasopharyngoscope.

Impression This is probably in the nature of a habit spasm.

Recommendation I would suggest a consultation with psychiatrist.

Consultation with A W Young, M D, September 12th and September 17th "After several interviews, I agree the clicking in the ears is made voluntarily by the patient. He has controlled it for short intervals. It disappears when he is asleep. The basis is simply a desire to leave his job of coal mining because of the fear which is constantly present when he descends into the mine. He is frozen to the job, and can only be released if ill and not fit for the job. He has feigned disability by making this clicking sound and complaining of headache. He has been told very definitely that he will receive no letter from us about his illness until the clicking ceases.

Therapeutic Procedures

Suggestion was used on the patient in the form of pennies placed over both mastoids. It was explained to the patient that copper would make the clicking cease. By the next morning the clicking had ceased entirely.

Condition on Discharge

Cured

Discharge Diagnosis

Tic of the levator palati muscles of psychogenic origin.

On April 16th, 1947, the writer and Dr R L Saunders, the anatomist, had the opportunity of re-examining this man in my consulting room. He stated that he was relieved of headaches for about two months after leaving Montreal—but they return if exposed to noise. As for the "tick" he had never been relieved although the doctors

Hugh W. Schwartz

claimed they were unable to hear it. On his return from Montreal his sister told me she had listened carefully and could not hear anything. On returning to work he was given a surface job. The patient's story is that he had only been back at work a short time when a stranger sitting next to him commented on the ticking noise he was hearing.

At this examination we found the rate was 100 and the loudness of the tick varied in intensity—at one time it could be heard at a distance of eight feet, then again only if the examiner placed his ear a few inches from that of the patient. This variation did not appear to follow any particular pattern. The only muscles not noticed before, either in Montreal or Halifax, was the obicularis oris. I was unable to confirm a fleeting impression that the ear drum shared in the movements. If the absence of nystagmus, using the ophthalmoscope as a refinement, can be interpreted as non-involvement then the IIIrd, IVth, and VIth cranial nerves can be ruled out.

The sister and brother-in-law helped by listening when they believed the patient to be sound asleep. During one night the brother-in-law tiptoed in to listen on three occasions and had no difficulty in hearing the tick at a distance of several feet. The sister listened on two other occasions and was able to hear it one time but not at the other.

We now have three examinations—July 1945, September 1945, and April 1947. The VIIth (facial) nerve had been passed as normal in July. Having the masseter and temporalis behaving as they did it is doubtful that any musculature supplied by the VIIth would have been missed.

In September the obicularis oculi was added and it is again doubtful that the obicularis oris would have been missed. In April the obicularis oris could be added as will be demonstrated in the moving picture. So it would appear that there is an element of progressiveness unless all concerned are unbelievably careless in making their observations.

It would then appear that the impulses are reaching their destinations *via* the motor division of the trigeminus, the facial and the hypoglossus beyond question. The traditional innervation of the Eustachian tube and soft palate is the vagus or the accessorius through the vagus with the exception of the tensor palati (dilator tubae) said to be supplied by the motor element of the 3rd division of the trigeminus. Some are of the opinion that the tensor is supplied by the facial. In addition it is not unlikely that the other palatal muscles are supplied by the glossopharyngeus (although predominately sensory) and the hypoglossus.

Our second point is that the audible element varies in loudness and this may have some bearing on the differences of opinion as to its cessation during sleep.

His sister thought that some idea of his history, character and disposition might help in arriving at a diagnosis. She said her brother was

Head Noises of Muscular Origin

subject to convulsions as a child. He is steady, kind and generous. A favourite with those with whom he plays baseball, football, hockey, etc.—as he is always able to smile—never gets cross—enjoys winning but never lets defeat worry him. With him the game is the thing. In short he is a good loser. His school record is good but might have been better had he not always kept “tomorrow” in reserve—in fact “tomorrow” was and is his favourite day. His unbounded faith in this day makes him quite irresponsible as regards the keeping of appointments. She stressed that he was a person who was more or less free from fear and as a boy would readily take a “dare”. Earning well he never had the urge to “get on” materially speaking as the other members of his family. He will play by the hour with his nephews and nieces whereas with most uncles a little goes a long way. The onset and development of the disorder seem more or less to have paralleled the period of courtship and marriage. He is happily married, is a good provider and never touches liquor. Their philosophical outlook on life is somewhat different. His is strictly scriptural, “Take therefore no thought for the morrow for the morrow shall take thought for the things of itself. Sufficient unto the day is the evil thereof.” Her’s is less scriptural and more worldly.

The number of cases reported of audible or objective tinnitus not associated with the circulation appear to be few and far between. Those authors cited by Bredlau in bringing the subject up to date in 1934, when he himself reported a case of his own in a child aged 9, made no mention of any other muscle involvement than that of the soft palate and Eustachian tube. Some had inferred that the musculature of the tube shared in the same rhythmic movements as the palate.

Bredlau in his comments says ‘It is generally agreed that objective tinnitus may be produced in either of two ways, namely, by disturbances of the vascular system about the head and neck or by contractions of the muscles around the Eustachian tube. The muscular type of tinnitus always produces a noise characteristically regular and rhythmic, either clicking or ticking, at the rate of about 100 per minute.

The origin of the sounds heard in the muscular type of objective tinnitus has been explained in a number of ways. The suggestion that the noise may be the result of friction of the ossicles or of vibration of the drum membrane does not appear to be tenable. Contractions of the stapedius or of the tensor tympani muscle seems to be too delicate an action to produce noises audible to an observer. The only explanation of the origin of these sounds for which definite evidence has been offered ascribes it to the clonic contractions of the muscles about the eustachian tube and the soft palate, the opening and closing of the eustachian tube, with the accompanying alternate separation and contact of the two moist surfaces, best explains the peculiar clicking sound. Hysteria

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and neurasthenia have been hypothecated as predisposing or contributing factors. Since such conditions are uncommon in children and since it is in children that this type of tinnitus has always occurred, this explanation is not plausible. Some cases of this type of tinnitus have been reported in which the symptoms disappeared and reappeared, but in case 1 the ticking has been constant on repeated examinations and the patient is unable to control it. So far as I have been able to determine, no case has been reported in which it was possible to arrest the noise permanently, but the absence of instances of the muscular type of tinnitus in adults shows that a spontaneous cure probably occurs as the child grows up."

The case now being reported is unusual among an unusual group in having muscles involved besides those of the Eustachian tube and soft palate. It might also be repeated that the age is 34, that the tinnitus gives rise to no inconvenience, that it has not remained "cured", and change of occupation has made no difference. The evidence that it ceases during sleep is by no means convincing, and there is reason to suspect progression.

During the preparation of this paper I learned that Dr. Hugh C. Wolfe of Greensboro, N.C., had a case of audible tinnitus. I made a direct enquiry and received a prompt reply in which he stated he had presented his case before the staff of the Piedmont Memorial Hospital in March 1938. Dr. Wolfe made the interesting observation that "In my case the muscles of the tube and palate are involved in making the ticking sound. The clonic contractions of the muscles are synchronous with the ticking. By actual count these were 164 ticks per minute with mouth closed, 140 ticks with lips open, and 70 ticks with mouth wide open".

Assuming that an organic cause can be dismissed then an emotional basis must be searched for and the functional character of the phenomenon established. If functional is it symbolic representing in a condensed form some underlying emotional difficulties and conflicts or is it a disturbance of the autonomic nervous system and expressed in focal tension? The one a psychologic response, the other a physiologic response to a disturbed emotional state.

In functional cases one may imagine he understands the loss or disturbance of a part of function with which the patient is familiar—such as the paralysis of an arm, a disorder of sensation, aphonia or amblyopia. The involvement of a part, the very existence of which is probably unknown, such as the Eustachian tube—makes the functional more difficult to even imagine. At this point perhaps it had better be left to the neurologist and the psychiatrist.

I wish to thank Dr. K. A. MacKenzie for permitting me to report his case.

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CLINICAL RECORDS

HIRUDO MEDICINALIS (MEDICAL LEECH) IN THE LARYNX: AN INTERESTING CLINICAL CONDITION FOUND IN IRAQ

By DAOUD SALMAN ALI (Baghdad)

DURING the last three years ten patients have presented themselves at the Out-Patient Department complaining of the following acute symptoms.

- (1) Hoarseness of voice.
- (2) Attacks of coughing.
- (3) Hæmoptysis.
- (4) Occasionally Dyspnœa.

There was a common denominator in all these cases, in as much as they all lived in northern Iraq where the custom is to drink water from running springs beside their houses, and if thirsty in the night to go outside and stoop over the spring and drink. In all cases this history was obtained and the significant fact in the history, was a sensation of feeling something "stick in the throat" soon after drinking.

On examination with a laryngeal mirror, a dark green elongated body was found to be sticking to some part of the larynx, usually the true vocal cord. It hung downwards through the glottis into the trachea. Occasionally it was found sticking to the aryepiglottic fold, and occasionally to the under surface of the cord.

If carefully watched for a few moments the greenish body can be observed to be undergoing contractions, and the diagnosis is made. If the larynx is now observed, using an anterior fissure laryngoscope, of the Jackson type, the body can be seen more clearly and transverse segmentation, with orange longitudinal lines can be detected; on stimulating the body it will be seen to contract violently.

The body is the common water leech (*Hirudo medicinalis*) which has been swallowed in the act of drinking.

The technique of removal needs care otherwise the worm may drop down the trachea.

Local anæsthesia with 10 per cent. cocaine is used, otherwise, if the worm is anæsthetized on using general it may drop down the trachea. Seize the worm with wide jawed forceps (e.g. Irwin Moore grasping forceps) grasping it firmly. On no account should the worm be pulled, otherwise it may tear, and a piece descend into the trachea. Steady pressure is applied for a few minutes and suddenly the worm relaxes its hold on the mucosa to stick to the forceps and it can be safely removed.

If the worm is already hanging down the trachea, attached to the under

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surface of the cord, we have put the patient into the Trendelenberg position, and on forcibly breathing the body of the worm slips proximally between the cords and then it can be removed in the usual way.

Once removed the symptoms are immediately relieved, though sometimes bleeding from the point of attachment occurs, which usually stops in a few hours.

Up-to-date we have had no complications following this unusual condition.

FORMATION OF CHOLESTEATOMA AROUND A DEPOSIT OF SULFA-POWDER

By L. B. W. JONGKEES (Utrecht)*

THE case of a 12 year old boy, who came to our clinic with a recurrence of a mastoiditis, may be of some importance for the valuation of primary closure in cases of mastoidectomy. The primary closure of the operation-cavity after mastoid operations has often been advocated since the sulfa-drugs and penicillin came into use. This treatment gives quicker healing and a shorter need of hospitalization.

The case of this boy, however, seems to show the necessity of some caution in performing the primary closure, as the use of sulfa-drugs does not prevent the progression of an inflammation in the middle ear or the mastoid cavity.

When J. was a boy of ten years he suffered from a recurrent middle-ear inflammation on the right side. Removal of his adenoids did not improve this and when a new attack continued for more than three months and did not respond to any conservative treatment, his surgeon opened the mastoid and removed all diseased bone. There was a fairly extensive destruction of bone, but at the end of the operation the cavity seemed to be quite clean. It was filled with sulfathiazole-powder and, but for a small piece of gauze, closed primarily. The further course was uneventful. The ear dried up very soon and the boy went back home. This was in July, 1946.

After the operation everything seemed to be all right. The ear remained dry for some months and hearing was fairly good. However, soon afterwards he caught a cold and the scar behind his ear became red and tender. It burst spontaneously, pus was evacuated and except for a small discharge from the ear the boy had no complaints. This discharge was not so profuse as to alarm the patient or his parents. In the course of the next two years there were some recurrences of the swelling behind the ear, but as they all burst spontaneously and healed in this way, the parents did not call a doctor.

However, on August the first 1948 a new swelling and tenderness did not heal spontaneously and the boy felt worse than in the previous instances, therefore the patient was sent to our clinic. Here we found the following condition. The left ear was normal. The right ear showed a red swelling and tenderness of the mastoid-area around the scar of the previous operation. The drum could not be seen because a descent of the upper-backwall of the external auditory canal made inspection impossible. There was a foul-smelling discharge. The whispered voice could be heard at a distance of 0.5M. On the Röntgen-films according to Schüller and Mayer a large destruction of bone was found. The temperature was 103°.

On account of these symptoms an inspection of the mastoid-cavity was made under general anaesthesia. After incision of the skin the old cavity was found to

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be filled with a big white clot, granular at the inside and clear cholesteatoma at the outside of the clot. A microscopical examination showed that sulfacryl crystals formed the granular inside and that the outside was bound by sheets of cholesteatoma. *Bacillus proteus* appeared to be the bacteriological agent. After removal of the big clot a large area of destruction towards the inside of the skull was found. The cholesteatoma had destroyed the tegmen area, laying bare the meninges, had destroyed the backwall of the auditory canal, causing its descent at otoscopy, and had denuded the labyrinth in such a way that after removal of all diseased bone and cholesteatoma the three semicircular canals were almost an anatomical preparation made by nature. In view of the large destruction we had to perform a radical mastoid operation. The further healing was uneventful and the cavity dried up very soon.

From this case it is obvious that under cover of sulfa drugs locally applied, destruction may proceed and may endanger the patient's life.

Summary a description of a case in which the formation of cholesteatoma proceeded around a depot of sulfathiazole. The cholesteatoma caused a large area of destruction behind the sulfa depot.

SOCIETIES' PROCEEDINGS

ROYAL SOCIETY OF MEDICINE—SECTION OF LARYNGOLOGY

May 7th, 1948

President : A. J. WRIGHT

Infra-Orbital Neuralgia

By G. C. KNIGHT

THERE are frequent points of contact between the specialities of Oto-rhinolaryngology and Neurosurgery. The object of this communication is to examine one facet at which our specialities overlap—namely that of pain in the territory of the trigeminal nerve which may occasionally be deceptive and lead to difficulty in diagnosis and treatment.

The trigeminal nerve runs a long course and there is a very close association between its branches and the nasal air cells. Occasionally the sphenoidal air sinus may extend as far as the semilunar ganglion or foramen ovale, and it is a fact that the introduction of cocaine into the sphenoidal sinus may produce complete trigeminal anæsthesia, indicating how thin a layer of dividing bone separates the sinus from the nerve.

The close relationship of the sphenopalatine ganglion to the nasal mucosa is also remarkable ; hence it is that certain cases of trigeminal pain occasionally have their origin in acute intranasal disease, but it is also true that atypical forms of primary trigeminal neuralgia may closely simulate the symptoms of primary intranasal suppuration.

It has been my experience that in the majority of cases intranasal operations are not followed by chronic pain and that many of those patients who suffer from persistent pain after nasal operations do so, not on account of some unrelieved condition in the nose, but from the persistence of a state that was present prior to operation which may occasionally be a psychalgia or atypical neuralgia that was mistakenly diagnosed as arising from intranasal causes.

The leading feature of psychalgic pain is that it is constant. Pain that is unremitting, that never leaves the patient, that changes in form but never in severity is always suspect; for true pain of organic origin must wax and wane as the causative disease varies in intensity ; it is sometimes better and sometimes worse, whilst typical or atypical trigeminal neuralgia occurs in characteristic paroxysmal outbursts. One should always beware of the patient with a distressing background or with little responsibility, ample means, and no vital interests who complains of pain that never leaves her.

With this passing reference to psychalgia it is proposed to confine the remainder of this discussion to two subjects, namely, infra-orbital neuralgia and sphenopalatine neuralgia, each of which may occur as primary lesions independently of nasal infection and yet may simulate the pain symptomatology

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of antral disease or affection of the deeper air cells With this object it is necessary to review the pathways for the conduction of pain stimuli from the paranasal regions

The trigeminal nerve is the only pathway for the conduction of pain from the nasal air cells I do not believe in the existence of sympathetic pathways which can produce pain in the head or in the paranasal region It is true that referred pain in the *neck and shoulder* may occasionally be attributed to reference through the sympathetic system, but after a complete section of the trigeminal nerve it is impossible to elicit pain in the nasal region by traumatizing the nasal mucosa although the sphenopalatine ganglion and vidian nerve are still intact Painful sensations that continue after a sensory root section are either psychalgic in origin or attributable to the escape of a few fibres in the sensory root which has left the trigeminal pathways partially intact as a result of an incomplete operation

The major portion of the trigeminal supply from the nose is conducted in the second division of the trigeminus, only a relatively small proportion returning in the first division The first or ophthalmic division passes through the sphenoidal fissure conducting pain sensations from the eyeball and lacrimal gland, from the upper portion of the nasal mucosa and the skin of the upper eyelid and midline of nose, and from the forehead and scalp as high as the vertex

The second or maxillary division passes from the foramen rotundum across the sphenomaxillary fossa to the infra orbital canal In the sphenomaxillary fossa it gives off its main supply to the paranasal sinus being connected to the sphenopalatine ganglion of Meckel by two or three stout filaments, the sphenopalatine nerves These constitute the sensory roots of the ganglion and pass directly from the maxillary division to the upper border of the ganglion, passing through the ganglion without forming contact with the ganglion cells, to be continued as the important sensory branches of distribution, which together innervate the greater portion of the nose nasopharynx and accessory air cells, the area of distribution covering the nasal mucosa except in the region of the inferior turbinate, the roof and septum of the nose the hard palate in the region of the incisors, the sphenoid and ethmoidal air cells and the nasopharynx in the region of the fossa of Rosenmüller

<i>Branches of distribution of sphenopalatine ganglion</i>	<i>Area of sensory distribution</i>
Ascending or orbital	{ Sphenoid Posterior ethmoids Periosteum orbit
Descending or large posterior palatine	{ Nasal mucosa except region of anterior and inferior turbinate Hard Palate Inside of gum Tonsil and soft palate
Accessory	
Internal or posterior superior nasal nasopalatine	{ Posterior superior nasal fossa Roof and septum and hard palate in region of incisors
Posterior or pterygopalatine	Nasopharynx fossa of Rosenmüller

These internal branches of distribution are to be regarded as the splanchnic distribution of the trigeminus as opposed to the somatic branches which, through

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the first, second and third divisions innervate the peripheral structures of the skin and jaws. Disturbances arising from the splanchnic territory may well have a different clinical character to similar disturbances arising in the area of somatic supply.

Anterior to the sphenopalatine ganglion the infra-orbital nerve enters the infra-orbital canal and is then distributed in branches to the wall of the maxillary antrum and to the incisor, canine and the first premolar teeth (the second premolar and molars receiving a separate supply through the posterior superior alveolar branch), and finally emerges from the infra-orbital foramen to supply the skin of the infra-orbital region. Pain arising from involvement of the infra-orbital nerve will therefore be confined to the cheek in the region of the ala of the nose, and the anterior portion of the upper alveolus, especially in the region of the canine fossa.

INFRA-ORBITAL NEURALGIA

Paroxysmal infra-orbital neuralgia occurs in two forms : it may appear as a presenting feature of trigeminal neuralgia and later spread to involve other branches of the trigeminus, or it may arise from local causes following upon dental extractions in the canine region and other operations in the region of the canine tooth, in which case the pain will remain entirely localized to the infra-orbital territory. Complete relief of pain may be obtained by infra-orbital avulsion in cases that have a local cause, but avulsion is an unsatisfactory method of treatment in trigeminal neuralgia as the pain will later extend to involve other branches.

Paroxysmal explosive attacks of pain of brief duration simulating the pain of trigeminal neuralgia may be seen in cases that have a local origin. Alternatively the pain may be continuous with exacerbations and remissions.

I recall the case of a Dutch seaman whose pain commenced following the extraction of his canine tooth. A constant pain was present in the region of extraction and in adjacent portions of the superior alveolus : there was a feeling of dull heavy pain in the cheek below the eye—an associated antral infection was suspected. The antrum was punctured, with negative results. Paroxysmal explosive outbursts of pain of great severity then commenced and occurred infrequently during the first year but later became more frequent. Complete relief followed avulsion of the infra-orbital nerve.

In other cases local pain has followed alveolectomy and in these, too, it has been possible to relieve the discomfort by infra-orbital avulsion provided that the pain was strictly confined to the region of the anterior portion of the upper jaw.

In post-herpetic neuritis the pain is usually widespread and involves a greater area than the territory of the infra-orbital nerve. Infra-orbital avulsion is therefore seldom to be considered in these cases, but I would recall that I have had experience of two patients in whom infra-orbital avulsion alone has succeeded in curing the pain. I would like to mention especially the case of a doctor in whom pain was experienced in the infra-orbital territory in the region of the canine tooth, in the lower lid of the eye and in the whole of the upper cheek, and also deeply behind the eye and deeply in the nose. The presence of pain in the eye and within the nose made me suspect that infra-orbital avulsion

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would fail, but in view of the great age and frail physique of the patient, who was forced to take large doses of opiates, it seemed that a small operation under local anaesthesia should be tried. A particularly large portion of the nerve was removed at operation and complete relief of pain was obtained except for some sore discomfort that continued in the nose in the region of a perforation of the nasal septum which received its supply through branches of the nasopalatine division.

I find that infra-orbital avulsion is ineffectual as a means of relieving chronic pain resulting from infection of the paranasal sinuses, presumably on account of the wider area of their nerve supply, excepting in those cases where pain is confined entirely to the region of the maxilla and canine fossa and upper teeth. Deep pain that is experienced in the region of the eye, the side of the nose, and hard palate requires an operation on the sensory root of the trigeminus in order to interrupt the important fibres that are supplied from the sphenopalatine ganglion.

SPHENOPALATINE NEURALGIA

The sphenopalatine or nasal ganglion is a small triangular reddish grey body with the apex downwards, situated in the upper portion of the sphenomaxillary fossa—lying beneath the second division of the trigeminal nerve—in close proximity to the nasal mucosa—at a depth varying in different dissections from 1.2 to 7.9 millimetres. It may occasionally occupy a direct submucous position or be replaced by two separate and smaller ganglia which are related to the sphenopalatine nerves.

The structure of the ganglion consists of sensory branches of the trigeminus and motor branches of the facial that are prolonged through its substance together with sympathetic ganglia cells which occupy a posterior position in the ganglion at its junction with the vidian nerve.

The sensory roots of the ganglion consist of two or three stout filaments of the sphenopalatine branches which pass through the ganglion to the nose and palate without being in any way incorporated with the cells of the ganglion mass.

The motor root is supplied by the great superficial petrosal from the geniculate ganglion of the facial. This nerve also conveys taste fibres from the anterior two thirds of the tongue which have passed *via* the chorda tympani to the geniculate and thence through the great superficial petrosal to Meckel's ganglion and will finally join the second division of the trigeminal nerve.

The sympathetic root of the ganglion consists of the great deep petrosal branch from the carotid plexus which joins the great superficial petrosal beneath the gasserian ganglion in the region of the foramen lacerum medium to form the vidian root.

The branches of distribution have been already referred to, but we may emphasize again that the trigeminal fibres of the sphenopalatine nerves are to be regarded as the splanchnic components of the trigeminus supplying internal structures as contrasted to the somatic peripheral branches of the first, second and third divisions. The pain arising from involvement of these branches differs from that of ordinary trigeminal neuralgia both in distribution and type. The distribution of the pain corresponds closely to the branches of distribution of the ganglion and also to the territory of the infra orbital nerve.

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In sphenopalatine neuralgia pain is experienced in the alar region of the nose and spreads laterally into the cheek and up to the infra-orbital region. At the height of the paroxysm the pain is also experienced deep inside the nose and in the hard palate and gums. The pain is of a continuous burning type and may last for twenty minutes or for many hours in each paroxysm, tending to spread to involve wider and wider areas during the attack ; it is often associated with a sensation of tension in the affected area ; it differs from trigeminal neuralgia in the longer duration of the paroxysms. Occasionally the symptoms will include loss of taste in the anterior two-thirds of the tongue. Physical examination, which is usually entirely negative, may reveal a slight reduction of sensation over the soft palate on the affected side and of the pharynx as far down as the tonsil. Vasomotor and secretory disturbances are occasionally observed in association with the attack, consisting of reddening of the conjunctiva and profuse secretion of tears. These phenomena have given rise to speculation as to the part that the sympathetic pathways may play in the causation of this pain, but bearing in mind the function of the great superficial petrosal nerve which is the secretomotor nerve to the lacrimal gland, the excessive tear secretion is easily understandable.

Sphenopalatine neuralgia may arise as a primary and independent condition without any associated intranasal suppuration. The syndrome is therefore by no means indicative of intranasal disease. With this qualification it is necessary in any discussion of this subject to pay tribute to the work of Dr. Greenfield Sluder for his extensive clinical and anatomical studies of the sphenopalatine syndrome. Sluder's original description of the sphenopalatine syndrome was published on May 23rd, 1908, in the *New York Medical Journal*, lxxxvii, 989 ; in it he gives an excellent description of the symptomatology :

" Occasionally it has been my lot to be consulted by patients who were in every way healthy and normal, but who suffered much of the time from headache which did not follow any of the known rules. Sometimes it was referred to behind the eyes, sometimes to the upper jaw in front, and sometimes to the hard or soft palate. Occasionally the nose was said to ache in the back, or the teeth were described as sore, or the pain was referred to the temple. Sometimes an indefinite sense of stiffness was described. These symptoms appeared from day to day, alternating one with the other, or associated two or three together. On one occasion I had them all described at once. I have seen some high grade inflammatory troubles in the posterior ethmoidal and sphenoidal sinuses, which have subsided and healed, usually within a week or two, but have left the train of symptoms, as described, in their wake, and these have continued on more or less indefinitely. This exceedingly irregular train of symptoms cannot be explained on a basis of inflammatory troubles in the accessory sinuses."

He points out the possibility of infection of the ganglion by the extension of sepsis from the nose and concludes :

" The distribution of the nerve processes of this ganglion corresponds closely with many of the regions to which pain is referred by these patients."

Sluder, in his numerous monographs, draws attention to the anatomical relationship of the sphenopalatine ganglion ; he points out the close proximity of the ganglion to the sphenopalatine foramen, a relatively exposed position which he thought might lead to the passage of infection from the nose to the

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ganglion He also drew attention to the fact that the sphenomaxillary fossa was related superiorly to the thin bone of the sphenoidal sinus and sphenoidal process of the palate bone, and posteriorly to the occasional prolongation of the sphenoid downward within the pterygoid process and great wing, and anteriorly to the thin posterior wall of the maxillary sinus He maintained that infection might transude from the thin bone in this situation and lead to inflammatory changes in the ganglion with resulting pain However, he drew attention to the fact that anteriorly the sphenopalatine ganglion was in relationship with the descending palatine artery and the sphenopalatine artery with their corresponding veins, and that these structures, together with surrounding connecting tissue, formed a protective pad which separated the ganglion by some 3 to 4 mm from the wall of the maxillary sinus forming the anterior boundary of the fossa, a finding which he thought might explain his belief that the characteristic disturbances of sphenopalatine neuralgia were more likely to follow upon inflammation of the ethmoid and sphenoidal sinus but were not at all likely to ensue from extension of infection from the posterior wall of the maxillary antrum Soon, however, evidence appears that even Sluder himself was beginning to doubt that all cases of sphenopalatine neuralgia were really of nasal origin

In 1910 in a communication to the Section of Internal Medicine of the St Louis Medical Society (*New York med J*, xc1, 850) he described two cases of typical sphenopalatine neuralgia occurring without previous nasal sinus infection and, in 1913, twelve cases of "systemic toxic origin" (*Trans Sect Laryng Otol, Amer med Ass*)

It may of course be true that an infection of the ganglion might follow upon infection of the nasal air cells in the manner that Sluder suggests This is a matter upon which I would appreciate your helpful comments in the subsequent discussion If it is true that sphenopalatine neuralgia CAN be a complication of nasal disease, it is equally true that paroxysmal explosive attacks of sphenopalatine neuralgia may arise as a primary condition as a variant of the more usual trigeminal neuralgia occurring in patients who have never had any evidence of nasal suppuration whatsoever

TREATMENT

In the past, many cases exhibiting the sphenopalatine syndrome have had their treatment commenced by various operative procedures on the nose, carried out in the belief that their pain arose from nasal causes In view of the fact that a nasal origin for this syndrome is by no means proven, I would suggest that intranasal operation should be undertaken in this condition only when positive proof has been obtained of the co existence of intranasal infection and that operations which are exploratory in character should be rigidly avoided

Local measures designed to produce a temporary relief of pain consist of cocaineization of the sphenopalatine ganglion The application of cocaine to the region of the sphenopalatine foramen produces a transitory effect which lasts approximately half-an-hour This short period of temporary relief may succeed in abating an attack and may cut short the severe symptoms of hypersecretion of tears and excessive nasal secretion that are sometimes associated with the syndrome Local measures of this kind can of course produce no

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permanent effect in those cases in which paroxysms of pain are frequently repeated.

Injection of the sphenopalatine ganglion is also an uncertain and unsatisfactory method. It is no mean feat to plant an injection directly into a structure 5 mm. in length which occupies an inconstant depth from the surface of the nasal mucosa. Many of the injections that have been performed have for this reason been merely periganglionic and have led to an exacerbation of the existing disturbance by production of scar tissue and inflammatory reaction around the ganglion itself. In other cases if certain anatomical variations are present or if the course of the needle is not perfectly directed, quite serious injury may be caused by attempted injection. Cases are recorded of injury to the nerves lying in the sphenoidal fissure produced by a needle that was imperfectly directed from the posterior palatine canal.

Sluder's technique of using a straight needle that is introduced beneath the posterior tip of the middle turbinate 0.66 cm. from its posterior margin appears to be the safest method of approach, but the results of these measures have been extremely inconstant. The injection of solutions of 5 per cent. phenol in alcohol has had to be repeated in many cases from three to ten times. Injection may be accompanied by a considerable pain reaction after a short period of comfort, and this reaction, which is the result of inflammatory disturbances in the region of the ganglion, tends to become more and more severe each time the injection is repeated—as Sluder says: "Severe cases of this kind are not only a terrible affliction for the patient. They may also put the Surgeon at his wits' end for judgment, perseverance, and skill." I would suggest that perhaps it were better not to embark upon so hazardous a course.

I would now like to recount two cases of sphenopalatine neuralgia arising as primary disease, independently of any intranasal suppuration, that have been completely relieved by sensory root section of the trigeminus.

CASE I.—Male, aged 42, complaining of paroxysms of pain in the left side of the face which had been present for seventeen years, occurring at intervals of approximately six to seven hours throughout the whole of that time. In 1930 this patient began to experience pain: the paroxysms began just lateral to the nostril and then spread laterally into the cheek and up to the infra-orbital region. At the height of the paroxysm he would also experience pain deeply inside the left side of his nose and also on his hard palate and gums on the left side. This pain was of a continuous burning type, lasting for about twenty minutes, then subsiding gradually and leaving his face sore. His paroxysms occurred approximately every six to seven hours and were usually of the same intensity. They were brought on by going out in the cold wind but there did not appear to be any special trigger area. He stated that if he had a cold he became free from the attacks or that they became less severe. His trigeminal nerve had been injected on four occasions with some analgesia but no relief from symptoms. Examination revealed no abnormal signs in the central nervous system.

In view of the suggestion that pain of this type might be conveyed through sympathetic pathways, an attack was elicited by stimulating the posterior part of the septal aspect of the left middle turbinate. This produced symptoms clearly recognized by the patient as the earlier stages of a typical attack; they

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included throbbing in the area of the pain, lacrimation in the left eye and a peculiar "early" pain deep in the face which preceded the full development of pain. The left cervical and thoracic sympathetic was then injected beneath the first rib by the posterior route, five minutes later sympathetic paralysis became evident with the development of a left Horner's syndrome. The left upper limb became hot and flushed, the left-sided nasal mucosa became very congested.

Repeated stimulation of the nasal mucosa again produced exactly the same symptoms of pain with lacrimation of the left eye, and some three minutes later he had a spontaneous and typical attack of pain at a time when the sympathetic paralysis was well developed, thus indicating that sympathetic block does not modify the onset or character of the attacks. At a later date a complete sensory root section was performed and from that date the patient has had no further attacks of pain.

CASE II —Male, aged 38. He experienced similar attacks of pain for four years and was completely relieved by a subtotal sensory root section designed to interrupt the fibres of the first and second divisions only, and in this patient also there was no evidence of any intranasal disease.

To summarize, it would appear that sphenopalatine neuralgia may occur as a variant of trigeminal neuralgia, independently of associated inflammation in the paranasal sinuses, that it is capable of complete and lasting relief by sensory root section, that the sympathetic pathways appear to play no part in the conduction of pain stimuli. It is possible that this condition may be of post herpetic origin and comparable to herpes of the geniculate ganglion.

E D D DAVIS said that for many years the Royal Dental Hospital had sent cases to his clinic at Charing Cross. The most common condition was alveolar pain following extraction. This was purely a local pain and he came to the conclusion that it was due to periostitis, possibly following upon absorption of bone subsequent to extraction. The treatment was to incise right down to the bone, and that procedure was successful in a few cases only. The relief afforded by injections of novocain was temporary. These cases often occurred in nervous, anxious women.

Infra-orbital neuralgia was a rare condition and was purely subjective. There were no visible signs and he believed these cases were part of a trigeminal neuralgia and the pathology or aetiology was obscure. There was nothing in the nose that he had found to account for the pain and nothing objective in the face. The pain in the auriculo temporal nerve from a lower molar tooth or some painful condition of the mandible was very characteristic. It spread to the ear and the side of the head almost up to the vertex. No local cause could be found in most cases of sphenopalatine neuralgia. He considered that it was a part of trigeminal neuralgia. He had not seen sphenoidal sinus suppuration or neoplasm accompanied by sphenopalatine neuralgia.

The speaker recalled a visit he had paid to a clinic in Paris, when some cases of sphenopalatine neuralgia were shown. These patients were treated by the application of wool soaked in cocaine on the area of the ganglion. They returned regularly to the clinic for their treatment and appeared to become cocaine addicts.

Another type of case which was difficult was the patient who complained of

Societies' Proceedings

pain near the intranasal antral window made in the inferior meatus by an operation. He believed that this was due to scarring involving one of the dental nerves.

J. A. HARPMAN, after referring to the use of cocaine on the sphenopalatine ganglion area for pain which in some cases he thought was vascular in origin, possibly sometimes with an allergic basis, said that it was now widely accepted that in some pain syndromes a peripheral interaction takes place between sensory nerve fibres subserving pain and sympathetic nerve fibres. He quoted some observers (e.g. Pollock) who, he thought, had found that sufferers from sphenopalatine ganglion neuralgia were not always relieved by cutting trigeminal nerve fibres. For these pains medical lines of treatment, such as the administration of nicotinic acid, benadryl or salicylates, frequently helpful for a while, often eventually failed to relieve. In women, sphenopalatine ganglion neuralgia was occasionally found to be worse just before a menstrual period and could then sometimes be relieved by progesterone. But by far the most satisfactory line of treatment he had yet found was cocainization of the sphenopalatine ganglion region followed by treating it with 1 per cent. to 2 per cent. silver nitrate solution; stronger solutions were liable to be irritating and sometimes caused a temporary flare-up of the pain.

G. C. KNIGHT, in reply, said that Mr. Davis had asked him whether he had encountered ulceration of the nose in association with sensory root section. He had seen herpetic ulceration in the nose follow this operation.

Another speaker had brought up the question of the pathway of the sympathetic as a means of conducting pain. It was perfectly true that pain could be referred through the sympathetic, but he would not accept for one moment that the persistence of pain after sensory root section necessarily meant that it had found its way back through the sympathetic. Anybody who had done trigeminal root sections would admit that he was bound to miss a few fibres occasionally. There might be just one or two fibres left, but it was quite amazing what an area those fibres could supply. It seemed to him that pain in the face and palate could not be sympathetic in origin, but pain in the shoulder and neck might be a referred pain.

FILM: LESIONS OF THE LARYNX

G. EWART MARTIN introduced a film of lesions of the larynx prepared by Dr. Louis Clerf of Jefferson Hospital, Philadelphia, who had kindly lent the film for exhibition in this country.

The film first showed a normal larynx. This was followed by vocal nodules and papilloma of the larynx and also papilloma of the trachea coming up between the cords. Following on this there was a case of keratosis of the cords; of carcinoma of the cords and epiglottis; and of tubercle of the larynx. That part of the film which showed tubercle of the larynx was, perhaps not so instructive because any duplication of a colour film tended to emphasize the reds and the photographs of the tubercle of the larynx did not show the characteristic pallor. Paralysis of the cords was also filmed and a very interesting case of functional aphonia, and finally injuries to the larynx.

Ewart Martin said that Dr. Clerf's film indicated a means of teaching students the appearance of the more common lesions of the larynx which was

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more impressive than drawings or even actual still photographs. Dr. Clerf had already published his method of filming the larynx with indirect laryngoscopy. The advantage from the teaching point of view was that it showed a mirror image of the larynx exactly as would be seen on indirect examination. It illustrated the difficulties that the student or practitioner might have in viewing the appearance and movements of the cords.

The film was also shown with the idea of stimulating those interested in cine photography to record their cases of lesions of the larynx.

ABSTRACTS

EAR

Further Labyrinthine Studies. S. H. MYGIND. *Acta Otolaryngologica. Supplementum* lxxviii, 1948.

I. AFFECTIONS OF THE HUMORAL SYSTEM OF THE LABYRINTH

This is a study of deafness caused by disease and is based on clinical experiments and histological examination of the internal ear.

As a result the author divides diseases of the ear into three groups, (1) The aerotympanic system. (2) The humoral system. (3) The nervous system. He gives an account of the characteristic symptoms of these three groups. He also gives a detailed anatomical and physiological description of the humoral system.

II. ON THE LABYRINTHINE TRANSFORMATION OF THE ACOUSTIC VIBRATIONS TO PITCH-DIFFERENTIATED NERVOUS IMPULSES

The author gives reasons for discarding the theory that pitch discrimination depends on elective vibrations of the basilar membrane and advances the theory that the decisive role is played by vibrations of the tectorial membrane pressing on the hair cells of the organ of Corti. This is consistent with the method of stimulation of the ampullae and otolith organs. The localization of the individual tones is due to the circumstance that each pitch makes the tectorial membrane subdivide into a number of secondary wave lengths, increasing from the apex to the base and being directly proportional to the frequencies concerned so that the same wave length is produced only in one place according to the pitch of the tone. The optimal wave length is that at which a hair cell and the appertaining Deiter's phalanx each are struck by opposite phases.

The article is closely argued with references to the literature and whether the reader agrees with the author's theory or not he cannot fail to be instructed by a study of this paper.

G. H. BATEMAN.

Aero-Otitis Media and Aero-sinusitis. G. K. ASCHAN. *Acta Otolaryngologica. Supplementum* lxxix, 1948.

Dr. Aschan has approached this subject in a manner not previously recorded. All previous writers have apparently accepted the physical theories of the causation of the barotraumas in man and have elaborated the details of this theory. Dr. Aschan used experimental animals and approached the problem with an open and receptive mind. Furthermore all his observations are based on histological and not clinical examination of his test material. He reports in considerable detail a most conscientious and careful series of well-controlled experiments and shows a large number of microphotographs to confirm the text of his experiments.

Firstly he found that rats were not suitable for these experiments because of the prevalence of histological upper respiratory and ear infections. Furthermore in these animals the eustachian tube is permanently and physiologically patent. His rabbits, with suitable precautions which he describes, were not subject to these infections and the eustachian tube is of the flutter valve type as in the human tube.

He finds in his rabbit experiments that he can produce mucosal changes in the ears and sinuses, similar to those caused by barotrauma described in humans, by oxygen deficiency or oxygen excess. He therefore argues that the oxygen state of the middle ear must be considered as a factor in the causation of the changes described by other authors as otitic barotrauma or aerosinusitis.

He argues his case very well and convincingly but there are some factors which he fails to mention. It is probable that he has disclosed a hitherto unrecognized factor in the production of the barotraumata but the reviewer thinks that it is a comparatively unimportant factor, at any rate, in otitic barotrauma. Some cases of sinus barotrauma have been impossible to explain on the reduced pressure basis and his explanation would cover many of these. Also delayed otitic barotrauma (McGibbon and Dickson) otyotitis (Behnke, 1945) are not satisfactorily explained by the pressure differential theory, whereas Dr. Aschan's oxygen poisoning theory will explain them satisfactorily.

This is a fascinating monograph which should be and will be read by all those interested in aviation otology. It is a pity that there have not been other papers on this subject based on experimental, as opposed to clinical evidence. This paper is written in English and is illustrated with forty four microphotographs as well as sketches and diagrams.

G. H. BATEMAN

The Detailed Audiogram H. A. E. VAN DISHOEK M.D. and J. VAN GOOL, Amsterdam, Netherlands. *Archives of Otolaryngology*, 1948, 47, ii, 149-154.

The usual audiogram with fixed frequency recording of the octaves of C is not satisfactory. A detailed audiogram showing all dips and defects of hearing in the tonal range in a quick and easy manner can be obtained by using a sweep frequency audiometer in the following way.

The intensity knob is fixed on the zero decibel level, viz., the minimum audible at 1,000 cycles per second, or 10-16 watt per square centimetre. Now the frequency knob is turned from low to high. The tonal range in which the howling tone is heard is recorded by means of a simple writing mechanism mounted on the frequency knob. Afterward the intensity is increased each time by 5 or 10 decibels till the howling tone is heard over the whole tonal range.

R. B. LUMSDEN

Bone-Dust-Free Lempert Fenestra Nov-Ovalis, A New Evolutionary Development of the Surgical Treatment of Clinical Otosclerosis JULIUS LEMPERT, M.D., New York. *Archives of Otolaryngology*, 1948, 47, iii, 280-288.

To further enhance the possibility of permanently maintaining the practical serviceable hearing following the Lempert Fenestra Nov-Ovalis operation, (1) a new method of creating a fenestra in the vestibule of the labyrinth without

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producing bone dust and bone splinters is described, (2) the clinical and histologic factors influencing the necessity for its development are given and (3) the advantages expected to accrue as a result of the new evolutionary development are stated.

(Those familiar with Simson Hall's work during the last two years will observe a close similarity of technique.)

R. B. LUMSDEN.

Otosclerosis: An Index of the Literature with Abstracts, for 1946. Archives of Otolaryngology, 1948, 47, iii, 310-332.

This is the third instalment of volume IV of *Otosclerosis* to be issued by the Central Bureau of Research of the American Otological Society, Inc. Several foreign articles and others heretofore unobtainable are listed or abstracted herein. Research on correlated subjects, especially if encouraged or supported in whole or in part by the Bureau, will also be included.

R. B. LUMSDEN.

A newer Concept of the Management of Otogenic Infection. MERRILL B. HAYES, M.D., Chester Pa. and C. FREMONT HALL, M.D., New York. *Archives of Otolaryngology, 1948, 47, iii, 289-302.*

Dibromosalicylaldehyde proved to be an effective agent in the treatment of ears infected with gram-negative bacteria and fungi.

R. B. LUMSDEN.

Penicillin Treatment of Nerve Deafness due to Syphilis. WALTER E. LOCH, and HAROLD A. TUCKER, Baltimore. *Ann. Otol., Rhin. and Laryng., March, 1948, lvii, 167.*

The author records the results of treating five patients with deafness, associated with acute syphilitic meningitis, and eight cases with late neurosyphilis and deafness. The group of eight neurosyphilitic patients with normal hearing, and three with conduction deafness due to middle-ear disease, were treated in comparable conditions as a control series.

In the patients with syphilitic meningitis, improvement in hearing was rapid and sustained. Of the cases with late neurosyphilis, four had no change in the hearing, but the remainder had a significant improvement, although this was slow. The increase in hearing acuity commenced with the low tones, followed later by a gradual improvement in the higher frequencies.

E. J. GILROY GLASS.

The Fissula ante Fenestram of the human otic capsule. BARRY J. ANSON, EARL W. CAUDWELL and THEODORE H. BAST. *Ann. Otol., Rhin. and Laryng., lvi, 957 (Part I. Development and normal adult structure), and lvii, 103 (Part II. Aberrant form and contents).*

The histologic structure of the antefenestral region of the otic capsule, between the vestibular window and the cochlea, is exceptional in that it consistently includes a cleft-like fissula occupied by unmodified connective tissue. This fissula ante fenestram extends vertically from the scala vestibuli to the tympanic cavity near the hamulus for the tensor tympani tendon.

Ear

The fissula appears in the 34 mm stage through invasion of the primordial cartilaginous capsule by the periotic connective tissue of the vestibule, with maturation, the periodic invagination becomes the connective tissue content of the fissular tract

During the process of ossification of the otic capsule, cartilage persists as the lining of the fissula. At its periphery endochondral bone forms, as early as the mid-term stage, an investing osseous shell

Peripheral islands of calcified cartilage (Intrachondral bone) occur abundantly about the fissula and throughout the fissular region

Typically, the fissula is an open S-shape in anterior coronal outline, narrow and cleft like, and occupied by connective tissue. The superior or tympanic part is commonly twisted at a 90 degree angle in relation to the inferior or vestibular portion

Variation in size and form is common. Occasionally the body of the fissula is capacious, it then had the appearance of pouch rather than cleft

The widened fissula may be occupied, in whole or in part by a cartilaginous mass, which can encroach upon the stapedial ligament in the presence of an auxiliary, or fenestral orifice

The fissular area is one of great histologic instability a circumstance which renders it vulnerable to pathologic change, the vestibular window subject to invasion and the stapes liable to fixation within its fenestra

(Part II) The range of histologic change within the fissular region has been determined throughout the normal course of foetal development through the phase of rapid rebuilding during early post-natal years, and through that of slower structural modification in adulthood. Additionally aberrant types of fissulae have been considered, especially in relation to the presence of chromatomatous masses. Observations suggest that the presence of newly formed cartilage is causally linked with the occurrence of exceptionally capacious fissular channels, and the formation of abnormal bone to the antecedent appearance of the cartilaginous nodules

For further study of the latter step in what appears to be a histologic succession, additional material is required and is currently being assembled in the otological collections at Wisconsin and North western. Only when the genesis of each participant tissue is further clarified and the degree of their interdependence better established, can more definite conclusions be reached (Author's summary)

Note —The papers summarized above which are too exhaustive to abstract are fully illustrated and worthy of study by those interested in the histopathology of the ear

E J GILROY GLASS

Special techniques for the Diagnosis and treatment of Psychogenic Deafness

WILLIAM G HARDY, Baltimore *Annals of Otology*, March, 1948, lvi

Some of the problems in the diagnosis and treatment of psychogenic deafness are discussed and emphasis is given to the fact that the most common finding is a psychogenic overlay on organic disease. Because this is true, a special diagnostic requirement is the ability to measure accurately the relative amounts of organic and psychogenic involvement. The burden rests directly upon the

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otologist, for he is the specialist most capable of interpreting hearing tests and of evaluating the otic pathology. The use of several special tests in the clinical work-up is discussed, and suggestion hypnosis is recommended as a simple means of measuring the organic and functional components.

Twelve cases, two of which are controls, are presented to illustrate the use of these techniques. Of special importance is the ease with which pure-tone and speech audiometry can be used with suggestion hypnosis for diagnostic purposes. The findings with deep suggestion are authenticated by follow-up tests. The key to the therapy, once the proportion of organic involvement is known, is the ability of the patient to gain insight into the relations between the causal factors and the symptoms. Under many circumstances this phase of the treatment can often be more readily accomplished by the otologist than by the psychiatrist. (Author's Summary.)

Note.—The paper, which is illustrated by twelve cases, is interesting, but the majority of otologists would probably feel that suggestion hypnosis was beyond their normal scope.

Observations on Bone Conduction in Fenestration cases—Physiological Considerations. ARTHUR L. JEURS (Chicago). *Ann. Otol., Rhin. and Laryng.*, 1948, lvii, 28.

The purpose of the paper is to record observations on the bone conduction of patients who have undergone the fenestration operation.

The Weber Test. The Weber test offers the simplest method of detecting an early significant post-operative drop in cochlear function, and therefore early recognition of serous labyrinthitis during the stage when this condition is most amenable to treatment. The general observation was that there was less initial gain in hearing in those patients in whom the Weber shifted to the unoperated ear four or five days following the operation after having initially lateralized to the operated ear. Such cases were treated by giving 200 c.c. of 50 per cent. sucrose intravenously at each of three treatments over a period of thirty-six hours. In a significant number of cases this shifted the Weber back to the operated ear. In a more recent series 50 c.c. Sorbital was substituted for Sucrose and thought more effective.

Study of the late post-operative bone conduction as compared with the pre-operative level and as compared with the unoperated ear in a series of twenty-eight cases, shows a tendency to improve on the operated side and also an apparent improvement on the unoperated side but the amount ranging from one to thirteen decibels would not appear to be of any great significance. Probably of greater significance is the observation that the increase is greater in the higher frequencies than the lower.

The exact physiology of sound conduction to the organ of Corti in the fenestrated ear has yet to be determined. In a certain number of cases a mild fistular symptom can be produced by pressure of the membrana tensa, the ocular phase being the opposite of that produced by pressure on the fenestra. Thus it would appear that a reversal of perilymph phase in hearing is at least a possibility, experimental evidence, however, is against such a conclusion.

An intact membrane is essential in obtaining maximum hearing improvement in the fenestrated ear. The most probable reason for this is the damping

Bronchi

effect of that part of the sound wave which is transmitted through the tympanic cavity to the round window. A perforation would decrease the pressure differential between the fenestra and the round window and consequently reduce the amplitude of the perilymph movement. Sound conducted through a small tube to within a few millimetres of the fenestra sounds much louder to the patient than when directed to the membrane indicating that the drumhead is not the principal receptor of sound in the fenestrated ear.

For an air-borne sound to produce a good displacement of the basilar membrane it must arrive at the two windows in a slightly different phase. Anatomical differences may influence this and in theory the further the fenestra is lateral to the round window the more favourable it should be. There are probable other factors of reflection of sound waves determined by the shape and angle of the canal and cavity which play a part in the final result, but these remain yet to be determined.

E J GILROY GLASS

The Fenestration Operation HOWARD P HOUSE (Los Angeles) *Ann Otol, Rhin and Laryng*, 1948, lvii, 41

The paper is a review of 500 cases. With slight modifications the Lempert nov ovalis technic was followed. The cartilage stopple, the gold burr and the more recent lead burr were not used. The mastoid cells are not completely exenterated and only the horizontal bony canal is skeletonized. Only a small cavity is therefore produced for epithelialization. The double blue line technic is followed.

In selection of cases a bone conduction oscillator is used. Ideal cases have less than ten decibel loss in the speech frequencies. Cases with a bone loss of less than twenty decibels in the 512 and 1024 frequencies and less than thirty decibels at 2048 are regarded as borderline while cases with a greater loss are regarded as unsuitable.

If a patient gives a history of hearing loss during a previous pregnancy and is again in the early stages of pregnancy operation is indicated to prevent further loss. Six such cases have been done during the third and fourth months of pregnancy. If there is a history of previous pregnancies without deterioration of hearing operation should not be advised till after term.

In the whole series approximately 66 per cent have maintained practical hearing after one year.

E J GILROY GLASS

BRONCHI

Progress in Bronchology LOUIS D CLERF, M D (Philadelphia) *Journal of the American Medical Association* March 13th, 1948, cxxxvi, 11, 733

Bronchoscopy was formerly employed largely for foreign body accidents, yet now, while these accidents have not diminished in number, less than 2 per cent of all bronchoscopic procedures are performed for this purpose.

In bronchogenic carcinoma biopsy yields a positive diagnosis in from 60 to 80 per cent of cases and an additional 20 to 25 per cent of cases of carcinoma can be diagnosed positively in lesions beyond bronchoscopic vision by cytological studies.

Endobronchial benign tumors have been successfully treated by removal and local diathermy.

In pulmonary abscess the trend has been away from bronchoscopy which now has little place in its medical treatment.

Bronchoscopy has a definite place in bronchiectasis in patients not suitable for operation. In bronchial asthma it is valuable in removing thick tenacious secretions and spectacular results have been secured even in moribund patients.

Bronchoscopy is utilized now only in cases in which post operative atelectasis does not respond to more simple plans of treatment.

Tuberculosis is no longer considered a contra-indication to bronchoscopy and it is employed in many cases as an aid to diagnosis.

Bronchoscopic cauterization preferably employing silver nitrate is often done.

ANGUS A. CAMPBELL.

LARYNX

Laryngeal Œdema in Epidemic Parotitis. JAMES S. WALKER and E. LAMONTE GANN (Baltimore). *Ann. Otol., Rhin. and Laryng.*, March, 1948, lvii, 163.

A clinical record of two cases of laryngeal œdema occurring during epidemic parotitis. Both were in coloured adults and the œdema occurred chiefly in the arytenoid area. The cords were not affected in either case.

E. J. GILROY GLASS.

Influenzal Laryngitis. DAVID W. BREWER and J. H. TOM RAMBO. *Ann. Otol., Rhin. and Laryng.*, 1948, lvii, 96.

While a number of cases of influenzal laryngitis and septicæmia in children have been reported in the literature of recent years, only two cases in adults, the first in 1936, have been recorded. In the series of six cases reported in this paper four were in adults.

The pathology of the condition was well-illustrated in one case an infant of nineteen months which died within ten hours of the onset of symptoms. Throat and blood cultures were positive for *Hæmophilus influenzae* type B. The primary pathology involved the epiglottis both clinically and at post-mortem. There was intense œdema and infiltration of the epiglottis, decreasing thence downward and with little or no subglottic reaction. This is in marked contrast to the pathological picture in streptococcal, tracheo-bronchitis, where the lesion is largely subglottic.

The remaining five patients aged 5 to 63 years all recovered. The clinical picture in all was sore throat, dysphagia and respiratory distress of short duration, low grade fever, but looking iller than the fever would indicate. Locally there was marked inflammatory œdema of the larynx most marked in the epiglottis. Positive throat cultures for *Hæmophilus influenzae* type B were obtained in all.

One case was treated with sulphadiazine and penicillin initially. After an initial improvement the condition became static for two weeks. Streptomycin therapy cleared the case up rapidly. Of the remaining cases treated with streptomycin two made an uninterrupted recovery, and two developed an

Nose

abscess of the epiglottis which delayed resolution No evidence of toxicity or sensitivity attributable to the streptomycin was observed

E J GILROY GLASS

NOSE

Orbital Complications resulting from Lesions of the Sinuses AUSTIN T SMITH and JAMES T SPENCER (Philadelphia) *Ann Otol, Rhin and Laryng*, 1948, lvii, 1, 5

A group of cases illustrating infections, mucocoeles, epidermoid cysts and osteomas of the nasal sinuses responsible for complications of the orbit, has been reviewed They show that the diagnostic problems involved are often complicated and that a thorough painstaking rhinologic investigation is required to avoid unnecessary delay in making an accurate diagnosis and in carrying out adequate therapeutic measures The laryngologist should be the first and not the last consultant in these cases, and for him it will frequently be a problem requiring the most careful observation and study (Author's Summary)

MISCELLANEOUS

Simultaneous Poliomyelitis in four brothers, two of whom had recently had Tonsillectomies A C HILDING (Duluth, Minn) *Ann Otol, Rhin and Laryng*, March, 1948, lvii, 217

A clinical record of simultaneous poliomyelitis in four brothers, two of whom had had tonsillectomy performed two weeks previously

The two unoperated, and one of the operated children developed bulbar symptoms The operated patient was very much more ill than the other two and eventually died However the second operated child was the only one of the four who showed no degree of bulbar palsy

It might be thought that a series of this sort would furnish an ideal situation for determining a causal relationship between tonsillectomy and bulbar poliomyelitis, but ignoring the fact that the number is too small to be of statistical significance, the issue remains beclouded

E J GILROY GLASS

Common Virus Infections of the Respiratory Tract JOHN H DINGLE, M D (Cleveland) *Journal of the American Medical Association*, April 24th, 1948, cxxxv 17, 1 084

Two distinct types of influenza virus have been isolated and characterized

In this article, the writer considers the present status of the diagnosis and etiology of other common respiratory infections whose differentiation and classification are as yet poorly defined These infections are thought to be caused by viruses but they can be segregated into a group only by the exclusion of cases of known bacterial or viral origin

Clinical classification is unsatisfactory

It now appears that three entities—the common cold, undifferentiated acute respiratory disease and atypical pneumonia—can be separated from the larger group Each of them can be transmitted to well human beings by the inoculation of bacteria free filtrates of secretions of the respiratory tract

Abstracts

The possibility of a fourth entity—non-bacterial exudative tonsillitis and pharyngitis—is indicated by clinical studies.

The article has a bibliography.

ANGUS A. CAMPBELL.

Surgical treatment on Intractable Unilateral Cephalalgia. WALTER G. HAYNES, M.D. (Birmingham, Ala.). *Journal of the American Medical Association*, February 21st, 1948, cxxxvi, 8, 538.

In vascular headaches all the available evidence suggests that the autonomic nervous system is implicated in the abnormal pulsation of the external carotid artery.

The writer has attempted to keep the pure migraine headache from this series.

Unilateral cephalalgia has been classified under the following headings :

1a. Temporal vascular headache, due to afferent sympathetic pain fibres accompanying the external carotid artery and its branches, is associated with severe unilateral pain, reddening of the conjunctiva, tearing of the eye and tenderness over the temporal artery.

1b. Occipital temporal vascular headache with radiation of the pain up over the occipital nerve and along the course of the temporal and middle meningeal arteries.

2. Cervical radiculitis, due to mechanical pressure on the great occipital nerve.

3. True intractable migraine.

The surgical treatment consists of exposure of the temporal artery and excision of a portion of this artery between silver clips. The incision is then carried through the temporal muscle, a burr hole is made over the middle meningeal artery and a portion of the artery excised between silver clips.

Seven cases are reported in detail.

Forty-seven patients have had this operation and 87 per cent. have been given lasting relief.

The article is illustrated, has two tables and a bibliography.

ANGUS A. CAMPBELL.

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